SCIENCE ABSTRACTS.

Section A.—PHYSICS.

MAY, 1932.

GENERAL PHYSICS.

1467. Natural Measure of Precision. J. Schive. *Bull. géodésique, No.* 30. *pp.* 161–164, *April–May–June,* 1931. *In English.*—Since the mean square error is the only known measure of precision which by all laws of errors makes the mean value the most precise the author considers this should be called the "natural measure of precision," and used in all cases. In many cases it is not used and the probable error is then less accurate. R. S. R.

1468. Determination of Thread Diameters by the 3-Wire Method. G. Berndt. *Zeits. f. Instrumentenk.* 51. *pp.* 560–574, *Nov.,* 1931.—Reference is made to Eden's procedure for the determination of the mean diameter of external screw threads. In this method a wire is inserted in a groove of the measured winding and two other wires of the same diameter in corresponding opposite grooves and their distance apart obtained with a suitable measuring apparatus with improved accuracy. An equation is obtained for the mean diameter in terms of the distance apart of the outer edges and diameter of the wires and the pitch and slope of the threads. The errors which arise in terms of each of the quantities are calculated for special cases and compared with the tolerances allowed. The most suitable size of wire to reduce the error for a given pitch is obtained for metric and Whitworth threads. Corrections are also obtained for the flattening of the wires and for the case of oblique threads. For two screw threads errors due to each of these causes are tabulated. R. S. R.

1469. Gravity and Time Measurements. O. Meisser, H. Martin and T. Gengler. *Gerlands Beitr. z. Geophys., Angew. Geophys.* 2. 2–3. *pp.* 131–307, 1931.—The problems of the pendulum are exhaustively treated. In the first part of the paper various types of pendulum are investigated, together with the adjustment, the theory of temperature compensation, electrical measurement of temperature, and determination of the period of swing. The second part is concerned with the measurement of time, and the photographic determination of the coincidence of two periodicities. A detailed investigation of the accuracy of the pendulum as time-measurer is given. The third part of the paper is devoted to the use of the free pendulum for the most precise time-measurement. Various clocks are considered, corrections to pendulum observations are investigated and various types of contact are discussed. W. A. R.

1470. Gravity Pendulum. J. Haag. *Comptes Rendus,* 193. *pp.* 1391–1392, *Dec.* 28, 1931.—The author shows mathematically how the theory of the gravity pendulum can be deduced as a special case of the theory of elastic suspension. The influence of temperature variations is also given. R. S. R.

1471. New Model of the Holweck-Lejay Pendulum. Value of "g" at Certain Points in France and Corsica. F. Holweck. *Comptes Rendus,* 193. *pp.* 1399–1401, *Dec.* 28, 1931.—In a third model of their elastic pendulum Holweck and Lejay have increased the sensitiveness to about 100 times that of an ordinary pendulum. It is only necessary to measure a period of 15 min. correctly to 0·1 sec. to obtain g correct to 2×10^{-3} c.g.s. units. The half period of the elastic pendulum 6 cm. long is 2·5 sec., and the author gives an account of the special construction necessary for exact adjustment, and for observation. The whole apparatus is made portable, so that it can be used in the field. Observations have been made at a number of stations, and are compared with those of other observers. H. N. A.

1472. Contact of Smooth Surfaces. S. H. Bastow and F. P. Bowden. *Roy. Soc., Proc.* 134. *pp.* 404–413, *Dec.,* 1931.—A number of experiments made during recent years have shown that, if a clean optically polished plate is lowered on to a similar plate in air, the two surfaces do not come into contact, the upper plate remaining "floating" at a distance equal to the thickness of several thousands of air molecules above the bottom one [see Hardy and Nottage, Abstract 1444 (1928); Watson and Menon, Abstract 2579 (1929)]. This phenomenon was discussed by Hardy [see Abstract 1742 (1931)], who considered it to be the most difficult problem of the boundary state. The experiments now described show that it is very difficult to place surfaces together without dust or solid particles coming between them. When somewhat elaborate precautions were taken and the surfaces were scrupulously clean, there was no evidence of "floating." A polished glass plate, lowered on to a similar plate in air at atmospheric pressure, sank quickly to within 0·45 μ of it. This small distance was the same whether the plates were in high vacua, alcohol vapour or nitroethane vapour, and it was not affected by changes of gas-pressure. In pure liquid alcohol water, the distance was 0·3 μ. Each plate was smooth to approximately 0·25 μ and this small remaining separation is almost undoubtedly due to the surface irregularities in the glass or to very small dust particles which were not excluded. T. H. P.

1473. Stability of Laminar Movements in Viscous Liquids. Part III. A. Rosenblatt. *Accad. Lincei, Atti,* 14. *pp.* 279–284, *Oct.,* 1931.—Proves that the series giving Ψ is convergent, the radius of convergence being inversely proportional to the Reynolds number corresponding to the perturbation of the first order. [See Abstract 1074 (1932).] See also *Phil. Mag.* 13. pp. 714–722, March, 1932. E. E. F. d'A.

1474. Motion in a Perfect Fluid. A. Quarleri. *Accad. Lincei, Atti,* 14. *pp.* 332–337, *Nov.* 1, 1931.—New and rigorous method, based on Hammerstein's non-linear integral equations, for ascertaining the characteristics of fluid motion, hitherto considered of insurmountable difficulty in the case of curved obstacles. Application to the case of a round cylindrical obstacle. A. D.

1475. Free Oscillations of Water in a Canal of Spindle-Shaped Plan. Part II. K. Hidaka. *Imp. Marine Obs., Kobe, Japan, Mem.* 4. *pp.* 273–283, *Nov.*, 1931. *In English.*—This entirely mathematical paper continues a previous investigation [see Abstract 3294 (1931)] of problems of water oscillations in various types of basins and canals, and deals in particular with the lowest five modes of oscillations of water in a canal of spindle-shaped plan. H. H. Ho.

1476. Steady Broadside Motion of an Anchor Ring in an Infinite Viscous Liquid. F. E. Relton. *Roy. Soc., Proc.* 134. *pp.* 47–57, *Nov.* 3, 1931.—The motion of an infinite viscous liquid in which an anchor ring is translated along its axis with constant velocity is investigated mathematically. The analysis employs orthogonal curvilinear ring coordinates using vectors, and the condition of continuity leads to a stream function connected with the vorticity by a partial differential equation of the second order. The equation of steady motion, ignoring inertia terms, is a similar equation in which the dependent variable is the vorticity. The motion thus depends on a fourth-order partial differential equation in which the dependent variable is the stream function. Two independent solutions of this equation are obtained in trigonometrical series involving associated Legendre functions of degree half an odd integer, the solutions tending to zero value at infinity. The resistance to the motion is derived. J. S. G. T.

1477. Resolution of Dirichlet's Problem by Riabouchinsky's Method, taking into Account the Calculation of the Velocity Potential. F. Vasilesco. *Comptes Rendus*, 193. *pp.* 1162–1164, *Dec.* 7, 1931.—The author discusses the questions of the existence of the potential functions, their calculation and boundary values in the case of the theory of cavitations developed by Riabouchinsky. J. S. G. T.

1478. Slow Motion of a Viscous Fluid in Two Dimensions with Fixed Boundaries. J. Leray. *Comptes Rendus*, 193. *pp.* 1165–1166, *Dec.* 7, 1931.—Slow motion of a viscous fluid within a channel of circular section and within a channel having a convex contour is discussed mathematically. J. S. G. T.

1479. Stability of a Single File of Straight Vortices. A. T. Jones. *Phys. Rev.* 38. *pp.* 2068–2070, *Dec.* 1, 1931.—An infinite number of straight vortices of equal strengths and the same sense of rotation are parallel and uniformly spaced in an infinite plane. If one vortex is slightly displaced, remaining parallel to the others, its velocity does not in general lie in a plane which passes through its original position. There are, however, two planes inclined at 45° to the plane of the file, such that if the displacement is in one of these planes the vortex moves directly away from its original position, and if the displacement is in the other plane the vortex moves directly back toward its original position. AUTHOR.

1480. Oberbeck's Vortices. D. E. Rutherford and J. Caldwell. *Phil. Mag.* 12. *pp.* 1190–1191, *Dec.*, 1931.—The authors critically discuss the paper on Oberbeck's vortices by Banerji and Barave [see Abstract 2911 (1931)], and show that the theory given is in error, thereby attributing the agreement found between theory and experiment to coincidence. Reply by **S. K. Banerji,** *ibid.*, 13. pp. 865–869, April, 1932. H. H. Ho.

1481. Aerodynamics of the Cylinder. W. Linke. *Phys. Zeits.* 32. *pp.* 900–914, *Nov.* 15, 1931.—Describes an investigation of the resistance experienced by a cylinder in an air-stream, with particular reference to the frictional resistance, determined as the difference between the total resistance and the simple pressure. The experiments were carried out under conditions for which the Reynolds number lay between 5000 and 41,000. For the smaller figure, the frictional resistance was 5 % of the whole but at the higher limit it sank to 2 %. The effect of holes in the surface of the cylinder was also investigated. J. W. T. W.

1482. Diffusion in Alkaline Copper Systems. V. L. Ricketts and J. L. Culbertson. *Am. Chem. Soc., J.* 53. *pp.* 4002–4008, *Nov.*, 1931.—The paper falls into two parts. In the first part, the theory of diffusion is very briefly considered, and expressions are given, in seven of the commonest cases, for the quantity Q. This is the quantity of diffusing material which is found in a defined volume at time *t*, and is found by integrating the expression for the concentration at any selected point, over the volume concerned. The second part employs diffusion measurements to investigate the constitution of the deep blue solutions characteristic of copper in alkaline solution when certain organic compounds containing the OH group are added. It has been claimed that these solutions contain colloidal cupric oxide, and the present results, whilst not disproving its presence, show that the blue component itself is diffusible and must be considered as a complex ion, and not as a colloid. J. H. A.

1483. Properties of Porous Building Materials. Parts I and II. E. Madgwick. *Phil. Mag.* 12. *pp.* 1155–1168, *Dec.*, 1931.—In Part I, the importance of absorbed water in building materials, as a factor in hastening decay, is emphasised. New methods of measuring the absolute porosity and the saturation coefficient are described, and results given for several materials. The saturation coefficient gives a measure of the extent to which the pores of the material are filled when it is soaked in water. In Part II, the flow of air through the material is considered, and experimental values of the coefficient of permeability are given. Equations are given for the air flow under a given pressure difference, through several porous materials arranged in series. J. H. A.

1484. New High-Vacuum System. J. A. Becker and E. K. Jaycox. *Rev. Sci. Instruments*, 2. *pp.* 773–784, *Dec.*, 1931.—A new high-vacuum pumping system is described in which oil is used in a diffusion-type pump, and a trap containing activated cocoanut charcoal replaces the usual liquid air trap. The system is capable of attaining a pressure of 2×10^{-8} mm. Hg. A high degree of vacuum can be attained at least as quickly as with a mercury diffusion pump and liquid air trap. The system is especially adapted to maintaining a low pressure for several days in apparatus which cannot conveniently be sealed off from the pumps. AUTHORS.

1485. High-Pressure Research Equipment. F. G. Keyes. *Indust. and Engin. Chem.* 23. *pp.* 1375–1379, *Dec.* 1, 1931.—A review of the subject, dealing not only with the measurement of pressures up to 1000 atmospheres, but also with measurements of temperature, etc., in a vessel where the pressure is high. The original paper should be consulted for details. J. H. A.

1486. Elastic Waves in Anisotropic Media. G. Lampariello. *Accad. Lincei, Atti*, 14. *pp.* 265–270, *Oct.*, 1931.—Generalised deduction of systems of differential equations and of the wave-surfaces, free from restrictive conditions as to plane waves or the homogeneity of the medium. [See following Abstract.] A. D.

1487. Waves of Discontinuity in Elastic Media. G. Lampariello. *Accad. Lincei, Atti*, 14. *pp.* 338–340, *Nov.* 1, 1931.—The author has referred [see preceding Abstract] to the case where the elastic medium has three orthogonal planes of symmetry and gives a potential depending on nine parameters; the present paper shows that perfectly analogous considerations apply to the case of an elastic medium anisotropic and heterogeneous and giving a potential which may contain the whole twenty-one coefficients and may also depend on the position and on the time. A. D.

1488. Elastic Ring. C. E. Larard. *Phil. Mag.* 12. *pp.* 1183–1188, *Dec.*, 1931.—As experimental test of the author's mathematical investigation of radial strains in an elastic ring [see Abstract 3692 (1931)] a mild-steel ring, 10 in. in diameter and with a radial thickness of 0·5 in., is compressed along a diameter. The results for this case, which provides a severe test, are in satisfactory agreement with calculation. J. P. A.

1489. Stresses due to a Circular Hole in an Elastic Plate. M. Davin. *Comptes Rendus*, 193. *pp.* 1318–1321, *Dec.* 21, 1931.—By considering mathematically the application of a symmetrical system of forces to the contour of a circular aperture in an elastic plane, the paper shows how to arrive anew at the state of stress of a body containing a circular hole and subjected at infinity to a uniform tension. J. P. A.

1490. Restricted Problem of Four Bodies. D. Buchanan. *Roy. Soc. Canada, Trans.* 25. *Sect. III. pp.* 27–38, *May*, 1931.—The motion of two infinitesimal particles, which repel one another and are attracted towards two bodies of equal mass, is studied. The attracting bodies are supposed large and at rest and all the forces obey the inverse square law. The solution of the equations of motion is given, under some simplifying assumptions. The theory is that of the normal hydrogen molecule with two nuclei and two electrons, treated according to classical dynamics. G. C. McV.

1491. General Equation of Brownian Motion. J. Métadier. *Comptes Rendus*, 193. *pp.* 1173–1176, *Dec.* 7, 1931.—Gives a solution of the general problem of Brownian motion in an external field of force, using the method of operational calculation which Schrödinger has employed in wave mechanics in the special case of constant fields, and which Destouches has recently generalised for varying fields. In the case dealt with by the author it is not necessary for the external forces to be in equilibrium with the forces due to viscosity, and the field may vary very rapidly. It is pointed out that the operator employed differs very greatly from that employed in wave mechanics; in the first place it is real, and in the second place it does not depend on the potential function V, but a differential operator div $\vec{v}$ is to be applied to p the probability. H. N. A.

1492. Crystallography of Rare Earth Halides. A. Pabst. *Am. J. Sci.* 22. *pp.* 426–430, *Nov.*, 1931.—The crystallographic data and optical properties of crystals of $SmCl_3 \cdot 6H_2O$ and $GdCl_3 \cdot 6H_2O$ are determined.

Observations are also made on $ErCl_3 . 6H_2O$ and $GdBr_3 . 6H_2O$. The crystallographic results for the first two are as follows:

Substance.	Crystal Class.	a : b : c.	β.	Cleavage.
$GdCl_3 . 6H_2O$	Monoclinic	1·4725 : 1 : 1·2185	86°20′	(100)
$SmCl_3 . 6H_2O$	Monoclinic	1·4713 : 1 : 1·2182	86°34′	(100)

Both are optically negative, one optic axis being nearly normal to the cleavage plane. The optical orientations are very similar in each case. $ErCl_3 . 6H_2O$ crystals are similar to those of $GdCl_3 . 6H_2O$ but it has not been possible to calculate the axial ratios. The optical orientation is similar to that of $GdCl_3 . 6H_2O$. The crystals of $GdBr_3 . 6H_2O$ are also monoclinic. The axial ratio is probably similar to that of $GdCl_3 . 6H_2O$. J. T.

1493. Chemical and Crystallographic Investigations on Complex Nitrites. Parts I and II. A. Ferrari and C. Colla. *Accad. Lincei, Atti.* 14. *pp.* 435–441, *Nov.* 15, *and pp.* 511–515, *Dec.* 6, 1931.—The triple nitrites of potassium, an alkaline earth metal and cobalt (or nickel) from monometric crystals of the " potassium cobaltinitrite " type [see Abstract 3328 (1930)], with four molecules in the unit cell. The constants and calculated densities are: $K_2Ca[Ni(NO_2)_6]$, $a = 10·29$ Å., density 2·75; $K_2Sr[Ni(NO_2)_6]$, $a = 10·49$ Å., density 2·88; $K_2Ba[Ni(NO_2)_6]$, $a = 10·67$ Å., density 3·02; $K_2Ca[Co(NO_2)_6]$, $a = 10·17$ Å., density 2·86; $K_2Sr[Co(NO_2)_6]$, $a = 10·23$ Å., density 3·10; $K_2Ba[Co(NO_2)_6]$, $a = 10·45$ Å., density 3·20. The similar triple nitrites with copper in place of cobalt or nickel give photograms which apparently contain the lines of two isomorphous monometric lattices. The compounds to which the formulæ, $6KNO_2, 3Co(NO_2)_2, H_2O$ and $2KNO_2, Co(NO_2)_2, H_2O$ have been attributed consist of the cobaltinitrite contaminated with cobalt hydroxide. The latter is probably formed during the hydrolysis of the cobaltous nitrite, this yielding also the nitrous acid which oxidises the bivalent cobalt to the tervalent form and so leads to the formation of the cobaltinitrite. The compound $K_4Ni(NO_2)_6$ is monometric and the side $a = 10·49$ Å. For potassium cobaltinitrite $a = 10·32 \pm 0·02$ Å. The virtual identity of the magnitudes of the constants of the unit cell and the almost identical positions of the lines in the photograms of these two compounds indicate the existence between them of strict isomorphous relationships, in spite of the different numbers of atoms in the two molecules. T. H. P.

1494. Theoretical Studies of Twinning. Part I. G. Aminoff and B. Broomé. *Zeits. f. Krist.* 80. 5–6. *pp.* 335–376, *Nov.*, 1931.—There are two cases, contact twins and penetration twins. In the former the surface of separation is a plane: this case only is discussed. For diamond, gold and lead sulphide (PbS), contact twins can be conceived as a growth phenomenon, in which layers are deposited on surfaces parallel to the contact plane. F. I. G. R.

1495. Crystal Structure of Monoclinic Pyroxenes. B. E. Warren and J. Biscoe. *Zeits. f. Krist.* 80. 5–6. *pp.* 391–401, *Nov.*, 1931. *In English.*—Diopside has the following parameters, $a = 9·71$ Å., $b = 8·89$ Å., $c = 5·24$ Å., with $\beta = 74°10'$. The following monoclinic pyroxenes are

closely similar, and can be said to have the diopside structure, hedenbergite, augite, clino-enstatite, acmite, jadeite. For spodumene (lithium calcium meta-silicate) the unit cell is smaller and of slightly different shape ($a = 9\cdot50$ Å., $b = 8\cdot30$ Å., $c = 5\cdot24$ Å., $\beta = 69°40'$). All these have four molecules in the unit cell. Two other minerals, wollastonite and pectolite, hitherto assumed to be monoclinic, are found to be triclinic The former contains six molecules to the unit cell and the latter two.
F. I. G. R.

1496. Structure of Silver Sulphate. K. Herrmann and W. Ilge. *Zeits. f. Krist.* 80. 5–6. *pp.* 402–415, *Nov.*, 1931.—The compound forms rhombic bipyramidal crystals with $a:b:c = 0\cdot4614:1:0\cdot8079$. Space group V_h^{24}, with 8 molecules in the unit cell. It seems likely that Ag_2SeO_4 is similar.
F. I. G. R.

1497. Spinel Structure. F. Machatschki. *Zeits. f. Krist.* 80. 5–6. *pp.* 416–427, *Nov.*, 1931.—The study of F-curves for intensities in the ordinary spinel structure shows that a value for the parameter u (oxygens) can be found in satisfactory agreement as regards Goldschmidt's empirical inter-ionic distances. Caution is needed in dealing with cases of one degree of freedom. [See also Abstract 3325 (1931).]
F. I. G. R.

1498. Structure of Ferromagnetic Ferric Oxide. J. Thewlis. *Phil. Mag.* 12. *pp.* 1089–1106, *Dec.*, 1931.—The crystal structure of ferromagnetic Fe_2O_3 is determined from considerations of intensity, atomic dimensions and rules of coordination. The structure is cubic, the side of the unit cube being $8\cdot4$ Å. as in Fe_3O_4, and the space group is O^6 (or O^7) or T^4. Fe and O atoms occupy the same positions as in the unit cube of Fe_3O_4, and there are four additional O atoms. A feature of the structure is that certain Fe atoms have a coordination number five. The structure satisfies the requirements of Heisenberg's theory of ferromagnetism regarding the number of nearest neighbours.
J. T.

1499. Heat-Treatment of γ-Monohydrate of Ferric Oxide. R. D. Williams and J. Thewlis. *Faraday Soc., Trans.* 27. *pp.* 767–771, *Dec.*, 1931.—X-ray photographs of $Fe_2O_3 . H_2O$ prepared from $FeCl_2$ by precipitation with $Ca(OH)_2$, and subsequent oxidation at room-temperature, show that its crystal structure is the same as that of the mineral lepidocrocite. The effect of heat treatment is investigated chemically and by X-ray analysis. Through the temperature range 250° C. to 300° C. the hydrate is converted to cubic Fe_2O_3 and through the range 500° C. to 600° C. this is in turn converted to rhombohedral Fe_2O_3. Changes in particle size are also observed.
J. T.

1500. Grating Constant of Calcite Crystals. J. A. Bearden. *Phys. Rev.* 38. *pp.* 2089–2098, *Dec.* 15, 1931.—Determinations on six crystals for four different sources, using $MoK\alpha_1$ radiations in the fourth order. The results are $3\cdot02816$ Å. at 20° C., $3\cdot02810$ Å. at 18° C.
F. I. G. R.

1501. New Type of Crystal Fine-Structure: Lithium Ferrite ($Li_2O . Fe_2O_3$). E. Posnjak and T. F. W. Barth. *Phys. Rev.* 38. *pp.* 2234–2239, *Dec.* 15, 1931.—The interpretation of the X-ray diffraction obtained from the isometric modification of lithium ferrite resulted in the conclusion that the smallest " unit " of this structure contains four anions and four kations. The anions, oxygens, occupy the four equivalent points 4*b* while the kations, iron and lithium, occupy together the four equivalent points 4*c*. The large difference in the scattering power of iron and lithium makes it possible to arrive at the definite conclusion that in the structure of lithium ferrite the same set of equivalent positions is occupied by the two chemically different elements (variate atom equipoints). It is shown that the distribution of iron and lithium in this set of equipoints is not regular, that is, there are not always two of each kation present in the " unit "; the distribution is one of chance, which, however, must comply with the requirement that an equal number of each of the kations is always present within a relatively small space. In view of these findings the conception of the unit cell loses its traditional chemical significance and becomes strictly a geometric conception. The " unit cell " of lithium ferrite has a meaning only if its lattice be regarded as geometric points in space. The lattice of lithium ferrite is then identical with the one of the " sodium chloride " structure (4*b*, 4*c*); the unit cube contains one molecule of $Li_2O \,.\, Fe_2O_3$, and the length of its edge is $4 \cdot 141 \pm 0 \cdot 005$ Å. The density of lithium ferrite is 4·368 and its refractive index $n_{Li} = 2 \cdot 40 \pm 0 \cdot 04$. AUTHORS.

1502. Coordination Number of Aluminium in the Alumino-Silicates. J. S. Hey and W. H. Taylor. *Zeits. f. Krist.* 80. 5–6. *pp.* 428–441, *Nov.*, 1931. *In English.*—In the three forms of Al_2SiO_5, andalusite, sillimanite, cyanite, aluminium is 4, 5 or 6 coordinated. A number of relationships respecting environment in the three minerals are discussed. Cyanite is triclinic, the other two are orthorhombic. It appears that the standard distance 1·9 Å. is slightly decreased in five-fold coordinated aluminium. F. I. G. R.

1503. Effective Radii of Atoms and Ions in Crystals. Part I. E. Herlinger. *Zeits. f. Krist.* 80. 5–6. *pp.* 465–480, *Nov.*, 1931.—Shows that the difference between the effective radii of the atom and the ion, when the latter has an electronic structure of the helium type, is about 0·8 Å. This is the maximum observed, and other constant differences of about 0·62 Å. and about 0·45 Å. are found, according to the structure type. From this it can be deduced that, when the ions are of the rare gas type of structure, the valency electron shells have a constant thickness (*Radiusanteil*), no matter how many electrons are present in them. Further that these shells do not affect the differences in the radii which occur in the successive atoms of the periodic system. Other interesting points with regard to effective radii are discussed. H. N. A.

1504. Dimensions of the Atoms in Crystal Lattices. G. Natta. *Accad. d'Italia, Mem.* 2. 3. (*Chim.*), [31 *pp.*], 1931.—With the object of determining the radii of the halogen ions in the crystalline lattices the reticular structure of the solid halogen hydrides was examined by means of X-rays. From the constants of HCl and HBr which are dimorphous and have a cubical structure at temperatures above 100° K. and from those of HI, which is tetragonal, were calculated the radii of the ions Cl^-, Br^- and I^-. These are respectively equal to those of the inert gases A, Kr, X, having the same electronic structure. The radii thus determined for the halogen hydride ions were taken as bases for the determination of the radii of the other monovalent ions. The principal results are given in tables. HCl possesses at the temperature of transformation from one form to the other an elementary cubic cell with 4 molecules having a side $a = 5 \cdot 435 \pm 0 \cdot 01$ Å., a volume of 161×10^{-24} c.c. The resulting density is 1·49. HBr has $a = 5 \cdot 76 \pm 0 \cdot 02$ Å., a volume of 191×10^{-24} c.c., and density 2·80. In HI $a = 6 \cdot 10 \pm 0 \cdot 01$ Å., volume $= 244 \times 10^{-24}$ c.c. and density $= 3 \cdot 46$. J. J. S.

1505. Estimation of Lattice Spacings from Resonance Forces. E. Cremer and M. Polanyi. *Zeits. f. phys. Chem.* 14. *Abt.B.* 6. *pp.* 435–442, *Nov.*, 1931.—According to London, the equilibrium positions of the molecules in the lattice result from an attraction potential of the form C/R^6 and a repulsion potential depending on quantum-mechanical resonance. If the difference between these two potentials is equated to the heat of sublimation (or lattice energy) and approximate values for the resonance forces are derived from optical data, the spacings of certain of the simplest molecule lattices (H_2, HCl, HBr, HI) may be calculated with reasonable approximation. T. H. P.

1506. Atomic Weight of Xenon. R. Whytlaw-Gray, H. S. Patterson and W. Cawood. *Roy. Soc., Proc.* 134. *pp.* 7–19, *Nov.* 3, 1931.—The method used was to compare directly the balancing pressures of O_2 and Xe by means of a sensitive microbalance. Full details of method and apparatus are given. The atomic weight found for Xe is 131·26 with an actual error of measurement of ± 0·01. H. H. Ho.

1507. Triatomic or Monatomic Hydrogen. G. R. Schultze. *J. Phys. Chem.* 35. *pp.* 3186–3188, *Nov.*, 1931.—This note is written with special reference to a recent paper by Binder, Filby and Grubb [see Abstract 3329 (1931)], and whilst the author disputes the contentions in this paper he does not wish to deny the possibility of an active form of hydrogen which may be attributable to an H_3 molecule even though physical evidence has furnished strong theoretical arguments against such a molecule. At the same time emphasis is laid on the point that mere proof of the existence of some sort of activation is not a sufficient basis for the assumption of the existence of H_3 when an explanation is available by means of the well-established atomic modification of active hydrogen. H. H. Ho.

1508. Calculation of Molecular Dimensions by Means of an Equation of State for the Surface Layers. P. P. Kosakewitsch and E. S. Uschakowa. *Zeits. f. phys. Chem.* 157. *Abt.A.* 3–4, *pp.* 188–202, *Nov.*, 1931.—It was found that all the substances investigated, forty in all, which were capillary active substances, behaved as strongly compressed gases at their surface layers on water solutions. The equation of Amagat was applied to the two-dimensional space of the surface layer. The smallest area which a molecule of a capillary active substance can occupy was found to be identical with the diameter of the molecule as determined by X-ray data. F. J. B.

1509. Normal State of the Hydrogen Molecule. N. Rosen. *Phys. Rev.* 38. *pp.* 2099–2114, *Dec.* 15, 1931.—The dissociation energy, moment of inertia and fundamental vibration frequency are calculated for a normal hydrogen molecule by a variational method and are found to be 4·02 volts, $4 \cdot 66 \times 10^{-41}$ gm.-cm.^{2}, and 4260 cm.$^{-1}$ as compared to the experimental values 4·42, $4 \cdot 67 \times 10^{-41}$ and 4380, respectively. The calculation is carried through with the simplest possible improvements in the wave functions. In the Appendix a number of integrals are listed and two tables of functions are included that may be useful to calculators. AUTHOR.

1510. Allotropic Modification of Solid Barium. E. Rinck. *Comptes Rendus,* 193. *pp.* 1328–1330, *Dec.* 21, 1931.—As pure barium is acted on by carbon dioxide it must be distilled in argon. The metal after being twice distilled in this gas has m.p. 710 ± 2°, $d_{4^\circ}^{17\cdot 2^\circ}$, 3·740. Both cooling/time and resistance/temperature curves show discontinuities at 375°, the α variety being stable below, the β above that temperature. [See also Abstract 2171 (1931).] C. A. S.

1511. Chemical Valency and Properties of Spectral Terms. A. T. Williams. *Phys. Zeits.* 32. *pp.* 870–875, *Nov.* 1, 1931.—The relationship $V_p + V_h = R - 1$ (where V_p = heteropolar and V_h = monopolar valency, R = a multiple), is found to be valid for all the elements considered, *viz.*, those of the first and second columns, the sub-groups of Al, C, N and O and the halogens. There appears to be a relationship between the numerical differences of the spectral terms and the change of valency for definite groups of elements whose electronic configurations are analogous. This relationship, which was first given by Narayan and Rao for the elements of the sub-group of Al, has been extended to the sub-groups of the above elements and Cu. Several other interesting relationships are recorded. [See also Abstract 2347 (1930).] H. H. Ho.

1512. Valency Variation and Atomic Structure. M. Gomberg. *Science,* 74. *pp.* 553–557, *Dec.* 4, 1931.—The subject is treated historically, starting with the first introduction of the idea of valency, and going on to discuss deficiency valence and excess valence, particularly in relation to the modern theory of atomic structure. Calls attention to the spectroscopic evidence that the valence electrons are not limited exclusively to the very outermost shell. There are almost 20 elements, the valence electrons of which must be considered as distributed some of them in the outer shell and some in the next underlying shell. In some of the rare earths the valence electrons are divided among three shells. It is supposed that the valence electrons in the different shells have different properties, and that this accounts for the different valencies observed for the same element. H. N. A.

1513. Collision Problems Involving Large Interactions. O. K. Rice. *Phys. Rev.* 38. *pp.* 1943–1960, *Dec.* 1, 1931.—A method is given for treating problems in which there is an exchange of electronic energy between atoms or molecules, with interactions which, treated as perturbations, are too large to be dealt with by the ordinary Born method. The case of good resonance is handled by Dirac's perturbation method, and the probability of a transition is found in terms of the perturbation (interaction) matrix component for the particular collision. With poor resonance it is assumed that the two bodies are held at a fixed distance apart, the perturbation due to the interaction is applied, and potential energy curves are constructed as a function of the distance, as if the whole system were a large molecule. The translational motion is then allowed to take place, which introduces further perturbations; these, however, are small, and relatively few transitions occur. In any special case the distance to which the two bodies must approach for a transition to take place can be calculated, and thus the radius of action can be found. If the transition is to take place with a large radius of action, compared with kinetic theory radii, then less energy can be transferred from internal to translational, or *vice versa,* than has hitherto been supposed. H. N. A.

1514. Structure of the Nucleus and its Total Moment of Momentum. S. D. Bryden, Jr. *Phys. Rev.* 38. *pp.* 1989–1994, *Dec.* 1, 1931.—The known values of the nuclear moment are classified in four divisions according to even and odd nuclear number and even and odd atomic number. All of the 31 cases are consistent with, and 12 cases in two divisions definitely support, the hypotheses that the electrons in the nucleus have no spin, and that the protons have a spin of $1/2$ in units of $h/2\pi$. These hypotheses are applied to the building up of the nuclei of equivalent protons, and the results indicate that: (1) There is an analogy between the construction of the nucleus of equivalent protons and the construction of the extranuclear portion of the atom of equivalent electrons. (2) Five quantum numbers are associated with the proton, corresponding to the five quantum numbers of the electron. (3) The rules of Pauli and Hund may be applied to the protons. (4) (ii) coupling predominates for the protons. (5) The nuclear moment is to be identified with the inner protonic quantum number of the normal nuclear state. (6) The nuclear moment I is in general the smallest I of the lowest I-group. (7) The order of filling of the protonic sub-groups is somewhat similar, especially for small nuclear numbers, to the order of filling of the electronic sub-groups of an atom. AUTHOR.

1515. Mass of the Proton. A. S. Eddington. *Roy. Soc., Proc.* 134. *pp.* 524–532, *Dec.* 2, 1931.—From the theory of the cosmical constant developed in a previous paper [see Abstract 1796 (1931)] it appears that the wave equation for an electron with momentum vector in the direction S is $(136 i\mathrm{E}_s \partial/\partial\theta_s + 1)\psi = 0$; here $d\theta_s$ is the natural measure of a displacement as given by the affine field theory, $d\theta_s^2$ being the affine invariant $\mathrm{N}R_{\mu\nu}dx_\mu dx_\nu$; the factor N represents the number of electrons (or protons) in the system. Reasons are given for supposing that this equation is incomplete and that the correct equation is $(10(i\mathrm{E}_s\partial/\partial\theta_s)^2 + 136(i\mathrm{E}_s\partial/\partial\theta_s) + 1)\psi = 0$, the factors 10 and 136 representing the number of degrees of freedom associated with the respective energy terms. The mass m of a particle satisfying this wave equation is given in natural measure by $10m^2 - 136m + 1 = 0$, or, in factors, $(135{\cdot}9264m - 1)(0{\cdot}0735692m - 1) = 0$. The two roots evidently correspond to electrons and protons, and their ratio is 1847·60. It is verified that the two roots represent charges of opposite sign. Since the mass of the electron given by the above equations is almost the same, the calculation of the cosmical constant is unaffected. H. H. Ho.

1516. Natural Units for Atomic Problems. A. E. Ruark. *Phys. Rev.* 38. *pp.* 2240–2244, *Dec.* 15, 1931.—This paper deals principally with two systems of units, designated A and B. In both, the velocity of light and the rest mass of the electron are taken as units. In A, the length unit is $h^2/4\pi^2 m_0 e^2$, which is the radius of the first Bohr hydrogen orbit; in B, it is $h/2\pi m_0 c$, which is $(2\pi)^{-1}$ times the Compton shift in scattering at 90°. In each system, the choice of the above units determines the unit of charge through the equation for the Coulomb force, $f = \epsilon^2/r^2$. In system A, the electronic charge is numerically equal to the fine structure constant, α; in system B, the square of the electronic charge is numerically equal to α, and h is equal to 2π. It is shown that many formulæ of quantum theory are greatly simplified when written in terms of system B; the coefficients of the Schrödinger and Dirac equations contain only small integers and the electronic charge. The use of these units provides a consistent scheme for simplifying the algebra associated with problems of quantum theory. AUTHOR.

1517. Scattering of Atoms. S. Mizushima. *Phys. Zeits.* 32. *pp.* 798–803, *Oct.* 15, 1931.—The scattering of an atom by another atom is treated by quantum-mechanical methods. The author enquires whether, when an atomic ray consisting of atoms of one kind impinges on an atomic ray of atoms of another kind, there is a maximum in the angular distribution of the scattered atoms, and, if so, how this maximum is connected with the wave-length of the de Broglie wave and how it is influenced by the Maxwell distribution. Calculation shows that there is a maximum, but that this maximum becomes obliterated on account of the Maxwell distribution. H. L. B.

1518. Physical Interpretation of the Wave Function in Wave Mechanics. U. Kakinuma. *Phys. Math. Soc., Japan, Proc.* 13. *pp.* 269–276, *Nov.*, 1931. *In English.*—In consequence of the previous consideration of the properties of a particular five-dimensional space associated with the electron [see Abstract 3349 (1931)] the author succeeds in deriving another field equation for the usual space-time world V_4 in such a way that it involves only the effects of an external field. An equation is derived which is formally identical with the Schrödinger equation. An interpretation of the wave-function is given as representing $\sqrt{E/E_0}$ where E and E_0 are the values of the energy density in the electron observed in V_4 and $\mathring{V}_4$ respectively, the latter being the world transformed so as to exclude the effects of the external field. The requirement of finiteness and continuity of the solution of the wave-equation leads to discrete values for the energy-density in the electron, a result quite similar to the case of a hydrogen-like atom. This suggests the significance of quantising as intimately connected with the inner structure of the atom. H. L. B.

1519. Concept of State in Quantum Mechanics. A. March. *Zeits. f. Physik,* 73. 1–2. *pp.* 107–117, *Nov.* 27, 1931.—By means of a simple example it is shown that contradictions arise if quantum-mechanical results are interpreted on the basis of the classical concept of state. The indefiniteness with which a quantum-mechanical experiment gives the quantities which define state must not be understood to signify uncertainty. Since the state of any system is represented by a vector in the Hilbert space, it can in general be determined only by an infinite number of experiments, even if we are dealing with the simple case of a single particle. H. L. B.

1520. Wave-Mechanical Treatment of the Problem of the Free Electron under the Simultaneous Action of a Homogeneous Magnetic Field and a Plane Electromagnetic Wave (Compton Effect in a Magnetic Field). F. Lüdi. *Helv. Phys. Acta,* 4. 6. *pp.* 375–397, 1931. *In German.*—The radiation of an electron bound by a magnetic field of arbitrarily great intensity is investigated on the basis of classical theory, quantum theory and wave mechanics. All three theories lead to the same frequency (double the Larmor frequency). The radiation is then considered in the magnetic field when the retardation is taken into account; the displacement of the spectral line can then be interpreted in Schrödinger's manner as a Doppler effect. Further, the electron in the magnetic field is perturbed by an electromagnetic wave, and the scattered radiation is investigated with the help of Waller's dispersion formula. When the direction of observation and the direction of incidence are parallel to the magnetic field the author obtains in the case of short waves (Röntgen waves) a Raman effect between the Compton radiation and the magnetic field, whereas in the case of long waves this effect is suppressed, as in the case of the oscillator. The case of oblique incidence and oblique direction of observation is also briefly considered. H. L. B.

1521. Some Difficulties in the Theory of Quanta. J. Solomon. *J. de Physique et le Radium*, 2. *pp.* 321–340, *Oct.*, 1931.—It is shown how the equations of the electromagnetic field proposed by L. Rosenfeld and the author [see Abstract **3344** (1931)] may be put in a form which clearly exhibits their analogy with those of Dirac. For this purpose it is very convenient to make use of the theory of "spinors," whose principles are briefly examined. The invariance of the theory with respect to Lorentz transformations then appears in a very striking manner. It is proved that for an isolated electron, in the presence of radiation, it is possible to suppress in an invariant way the characteristic electrostatic energy of the electron, but the value obtained for the energy of interaction between the electron and the radiation remains infinite. The negative states of energy which result from the equation of Dirac are also investigated. It is shown that the transitions in question take place very near elementary particles of the order h/m_0c. The fields which exist there are extremely intense, and it is probable that the equation of Dirac no longer holds there. This allows various inferences to be drawn, in particular with regard to the theory of the structure of the nucleus. [See following Abstract.] H. L. B.

1522. Electrodynamics and the Theory of Quanta. J. Solomon. *Ann. de Physique*, 16. *pp.* 411–502, *Dec.*, 1931.—The purpose of the author is to perfect the quantum theory of the electromagnetic field, particularly with regard to the energy of radiation at the absolute zero. The modifications which the quantum theory causes in the notion of the electromagnetic field are studied, and the author shows how one is led to build up a Hamiltonian quantum theory of the field. The usual generalisation of Maxwell's theory leads to a difficulty in the energy of radiation at the absolute zero. New Hamiltonian equations are suggested which lead to results which differ but little from those given by the classical theory, the difference tending to zero with Planck's constant. Consequences of the new theory are traced, a particularly simple study of the question of the fluctuations of black body radiation and Einstein's formula being given. The interaction of the electromagnetic field with matter is also discussed. [See also preceding Abstract.] H. L. B.

1523. Evaluation of Matrix Components for Helium. L. P. Smith. *Phys. Rev.* 38. *pp.* 1961–1968, *Dec.* 1, 1931.—An expression involving a certain number of differentiations has been obtained for the matrix components involved when the first order correction to the wave function is desired starting from the product of hydrogen-like wave functions and treating the electrostatic interaction energy between the two electrons as the perturbation energy. The result given holds for all discrete states. AUTHOR.

1524. Quantum-Mechanical Reflection Coefficients and their Numerical Determination. V. Rojansky and W. Wetzel. *Phys. Rev.* 38. *pp.* 1979–1988, *Dec.* 1, 1931.—A method, based on the use of

Milne's function w, for the numerical determination of quantum-mechanical reflection coefficients in one-dimensional problems to any preassigned degree of accuracy is outlined. The case in which a " barrier " is both preceded and followed by a field-free space is considered in detail, and a numerical example is worked out. The procedure in the case in which a " barrier " is preceded by a field-free space and is followed by a potential for which Schrödinger's equation can be solved analytically is outlined, and the special case in which a " barrier " is followed by a uniform field is considered in some detail. The case in which a " barrier " is both preceded and followed by potentials for which Schrödinger's equation can be solved analytically is mentioned. Formulæ are given for the evaluation, in terms of ψ and its first derivative, of the respective densities of the dextral and of the sinistral current flowing past any point x in regions where the total energy is greater than the potential energy. A procedure is given for finding solutions representing unidirectional beams at infinity. AUTHORS.

1525. General Solution of Schrödinger's Equation and the Uncertainty Principle. E. L. Hill. *Phys. Rev.* 38. *pp.* 2115–2121, *Dec.* 15, 1931.—It is shown that the general solution of Schrödinger's equation in one dimension for a given energy can be written in a form representing two beams travelling in opposite directions with the classical velocity. This permits an interpretation of the uncertainty principle in which an electron in a conservative field, with a definite energy, has also a definite speed, but its direction of motion is indeterminate. In regions in which the classical velocity is imaginary this interpretation becomes indefinite. A brief consideration is given to the generalisation to three dimensions. AUTHOR.

1526. Conditions of Application of the Principle of Relativity. J. le Roux. *Comptes Rendus*, 193. *pp.* 698–700, *Oct.* 26, 1931.—The author discusses very briefly the analytical transformation of coordinates in two systems. The theory resembles that due to Lie, with this difference, that whereas in Lie's theory the parameters are constant, in the present theory they are variables. J. S. G. T.

1527. Relativity Group of Transformations in Classical Mechanics. J. le Roux. *Comptes Rendus*, 193. *pp.* 1389–1391, *Dec.* 28, 1931.—The fundamentals of dynamics are shown to be derivable from the relativity expression of kinetic energy. J. S. G. T.

1528. Equations of General Relativity. C. Racine. *Comptes Rendus*, 193. *pp.* 1167–1169, *Dec.* 7, 1931.—The conditions are found under which a Riemannian continuum of 4 dimensions with a statical line-element reduces to a Euclidean one. G. C. McV.

1529. Unified Theory of Gravitational and Electromagnetic Fields. S. Kunii. *Kyoto Coll. Sci., Mem.* 14. *pp.* 195–212, *Sept.*, 1931. *In English.*—A variant of the usual type of unified field theory based on a four-dimensional continuum possessing an asymmetric connection of the semi-symmetric type and a metric. Field equations are derived by Hamiltonian differentiation of invariants and by assuming that there is an energy-tensor in the field of the same form as in the theory of general relativity. The equations of motion of charged particles can then be derived. G. C. McV.

1530. Solutions of Einstein's Gravitational Equations. G. Haenzel. *Zeits. f. Physik,* 72. 11–12. *pp.* 798–802, *Nov.* 16, 1931.—Linear geometrical principles and the theory of involution due to St. Jolles [*Math. Zeits.* 1927. 27. 427] are applied to deduce the characteristics of the Einstein and the de Sitter space-time universes. J. S. G. T.

1531. Deflection of Light in the Sun's Gravitational Field. J. Jackson. *Observatory,* 54. *pp.* 292–296, *Nov.,* 1931.—A short account of the results of the Eclipse Expedition of May 9, 1929, undertaken by Freundlich. The deflection of light by the sun is found to be 2″·0 to 2″·2 and is definitely in excess of the theoretical value of 1″·75. This confirms the conclusion, suspected from former measurements, that Einstein's theoretical value is smaller than that actually observed. G. C. McV.

1532. Electrostatic Analogue of Gravitational Red Shift. R. J. Kennedy and E. M. Thorndike. *Nat. Acad. Sci., Proc.* 17. *pp.* 620–622, *Nov.,* 1931.—Account of an experimental investigation which demonstrates that a difference in electrostatic potential between the places where light is emitted and received gives rise to no observable red shift. G. C. McV.

1533. Theoretical Requirements for the Periodic Behaviour of a Universe. R. C. Tolman. *Phys. Rev.* 38. *pp.* 1758–1771, *Nov.* 1, 1931. —It is shown that the matter in a universe expanding and contracting between given limits and filled with a uniform distribution of fluid, would not satisfy the condition for reversible changes which must be obeyed according to the generalised thermodynamics developed by the author. If, however, the universe expands from zero proper volume to a finite radius and then returns to zero without the conditions for a minimum proper volume holding at the lower limit the changes in the fluid are thermodynamically reversible. This is the case for the model of the universe recently put forward by Einstein. [See Abstract 703 (1932).] G. C. McV.

1534. Expanding Universe. W. H. McCrea and G. C. McVittie. *Roy. Astron. Soc., M.N.* 92. *pp.* 7–12, *Nov.,* 1931.—The authors point out that the metrics employed by them for an expanding universe in which a condensation has formed at the origin also possess a condensation at the antipodes of the origin. When the effect of this second condensation is allowed for, the volume of the universe with the condensations is, to the first order, the same as that of the original Einstein universe. The question as to whether or not the formation of condensations would start an expansion of the Einstein universe is therefore left open. The authors criticise the treatment given by Lemaître of this problem and point out the reasons why, in their view, no solution is obtainable by Lemaître's method. G. C. McV.

METEOROLOGY, GEOPHYSICS AND ASTROPHYSICS.

1535. Measurement of Visibility at Night. W. E. K. Middleton. *Roy. Soc. Canada, Trans.* 25. *Sect. III. pp.* 39–48, *May,* 1931.—Visibility at night is defined as the distance at which a standard light is just visible to the unaided eye of an observer with normal eyesight. Measurements are made by observing a lamp at a known distance, the light passing through an adjustable wedge and an inclined plane-parallel glass plate to the eye. Light from an artificial star is also reflected by the plate to the eye, and equality of illumination obtained by adjusting the wedge and then reading on the attached scale. The theory, involving a single coefficient to include absorption and scattering in the atmosphere, is given, and also the determination of the constants. Lamps at 200 m. and 1000 m. are used in practice for moderate and good visibilities respectively. Experimental results obtained are to be given later. R. S. R.

1536. Visual Signalling Meteorograph. J. Patterson. *Roy. Soc. Canada, Trans.* 25. *Sect. III. pp.* 115–120, *May,* 1931.—The present balloon meteorograph is limited by (1) use in populated regions to give a fair chance of recovery, and (2) the delay in recovery and knowledge of results obtained. The apparatus described consists of an aluminium framework carrying a rigid spiral thermoelement connected to a pen arm. Registration is obtained by means of a grid consisting of a small block of alternate layers of German silver and bakelite. It carries on the back three lugs joined to one red and two white lamps. The aneroid is also connected to a flashlight. Change of pressure by a fixed amount is indicated by a flash, while the arrangement of the three lights around a pilot light indicates a falling or rising temperature, and a flash occurs at intervals of 2° C. The wind direction and velocity are obtained by following the balloon through a theodolite. A figure shows the trace obtained in the first flight to a height of 7700 m. Precautions are required in the Arctic against low temperatures for the battery. R. S. R.

1537. Improved Method of Sounding the Lower Layers of the Atmosphere. G. Chatterjee. *Indian Meteorolog. Dept., Sci. Notes,* 4. 35. *pp.* 49–51, 1931.—The open-scale meteorograph [see Abstract 1134 (1932)] is attached to a balloon rendered self-deflating by a device whereby a solution of chromic anhydride in sulphuric acid comes into contact at the desired height with a thread soaked in solution of potassium chlorate, consequent destruction of which releases the hydrogen in the balloon. C. A. S.

1538. Temperature of the Lower Atmosphere of the Earth. E. O. Hulburt. *Phys. Rev.* 38. *pp.* 1876–1890, *Nov.* 15, 1931.—The temperature of the atmosphere in radiative equilibrium is calculated on the assumption that sunlight is the only source of energy, but a more rigorous calculation than heretofore, although approximations are still made. The results obtained show that the atmosphere would not be dynamically stable, since sea-level temperature would be about 19° K. above the normal world average of 287° K., and also the temperature gradient would be greater than observed and convective currents would be set up. Only when convective regions extend to about 12 km. (as observed) and with radiative equilibrium above 12 km. (as observed) is stability obtained. Thus calculated sea-level temperature is 290° K. Increasing the carbon dioxide content of the air increases the temperature and *vice versa*. Such changes may be the cause of ice-ages as suggested by Tyndall. H. M. B.

1539. Formation of Cirrus Cloudlets at the Seat of Pilot Balloons at Great Heights in the Tropics. E. Kuhlbrodt. *Gerlands Beitr. z. Geophys.* 34. (*Köppen Band,* 3.) *pp.* 9–20, 1931.—On the German Atlantic expedition of 1925–27 cases were observed in the inner tropical regions of small cloudlets of cirrus form produced near to rubber balloons at the time when the balloon disappeared. The elevation, height and distance of the balloons are tabulated for 26 cases and sketches given of the cloud forms. They were most frequent at heights of 16–19 km. and especially at 18–19 km., while measurements indicate that they formed at the lowest part of the stratosphere. The diameter was about 50 m. The phenomena are comparable with those observed behind aircraft in high ascents and in Greenland at low temperatures when supersaturation for ice-vapour exists. The formation is discussed according to the procedure given by Wegener for the Greenland observations. At the particularly low temperatures of high levels in the equatorial regions conditions are favourable for supersaturation. The nuclei of condensation are provided by talc dust inside the balloon and water vapour in the rubber, while the sudden expansion and cooling when the balloon bursts also assists in the cloud formation. R. S. R.

1540. Method of Radio Testing and its Application to the Exploration of the Higher Atmospheric Levels in the Polar Regions. P. Moltchanoff. *Gerlands Beitr. z. Geophys.* 34. (*Köppen Band,* 3.) *pp.* 36–56, 1931.—Details are given of a form of apparatus used to transmit wireless signals to indicate temperatures and pressures during its ascent. Results are then given of a series of ascents made on Katharine Island, Murmansk, in Jan., 1931, and the corresponding weather charts for several successive days are shown. These illustrate the inversion formed in the upper air as a depression approaches and its descent as the depression gets nearer, the steep temperature-lapse rate in the polar air in the rear of the depression, and also an inversion descending to the ground during the day under a cloudless sky as a result of terrestrial radiation. The curves are of interest in that the inversions were obtained during the night and were unaffected by insolation. R. S. R.

1541. Use of Equivalent Temperature in Official Weather Practice. L. Aujeszky. *Gerlands Beitr. z. Geophys.* 34. (*Köppen Band,* 3.) *pp.* 131–141, 1931.—The author reviews the historical treatment of equivalent temperature, its importance in identifying air masses and tracing their movements and its value in forecasting. It is shown that in the high levels the equivalent temperature is very little disturbed. Lack of time in most forecasting offices prevents the use of this factor from existing data. The author suggests the insertion on weather charts of TT/SS where TT is the air temperature (°C.) and SS = TT + H, where H is the first figure of the percentage relative humidity. It is shown that TT and H are affected oppositely by radiation and errors due to exposure while little time is expended in showing this extra information. R. S. R.

1542. Quantitative Hydrometeors. A. Gião. *Gerlands Beitr. z. Geophys.* 34. (*Köppen Band,* 3.) *pp.* 142–163, 1931. *In French.*—Starting

from the laws of thermodynamics and hydrodynamics, equations are obtained for the vertical movement of the air as a function of the field of pressure, assuming, (1) adiabatic motion of the air, (2) the real horizontal wind equals the gradient wind, and (3) the horizontal variation of air density can be neglected. From the forecasted field of pressure, the fields of temperature and relative humidity are then obtained, and from these the regions of clouds and their intensity are found, allowance being made for the heat of condensation while the effects of supersaturation are neglected. The system of movements and pressure variations of a normal perturbation give rise directly to an extensive and regular cloud formation whose base falls, and thickness increases, towards the centre of the perturbation. In this way a physical explanation of the cloud systems in the forward, central and rear zones of a depression is obtained without the introduction of surfaces of discontinuity on the Norwegian plan. The medium and low clouds are formed solely by local decreases of pressure. Reasons are given for the differences of these concepts for air motion, cloud formation and rain areas in a depression from Norwegian ideas. Perturbations from the N. or N.W. reaching France which possess cloud systems and produce precipitation without any defined frontal zones can be explained in this way. The formation of cumulus in the rear of a depression is considered as due to feeble air oscillations, shown by wind fluctuations, and the steep temperature-lapse rate in the polar air only accentuates the effect. The formation of surfaces of subsidence are examined on these lines. The warm front inversion for a depression is supposed due to the slower cooling in the region where precipitation occurs and has thus a mechanical origin while thermal inversions above cloud layers are due to the absorption of solar radiation at the top of the cloud.
R. S. R.

1543. Wave-Length of Air Waves. B. Haurwitz. *Gerlands Beitr. z. Geophys.* 34. (*Köppen Band,* 3.) *pp.* 213–232, 1931.—Reference is made to investigations by Helmholtz, Wien and Wegener on this subject. Calculations of the wave-length of waves at the boundary of two air currents, having different densities and moving with different speeds, give too great a value if the vertical decreases of density and compressibility of the atmosphere are neglected. If the former only is considered, the wave-length value is too small, but introduction of the latter, also, leads to satisfactory agreement with experimental results obtained during kite-balloon ascents. It is shown that neglect of these two factors attributes to the atmosphere too great a stability and using only the former gives too small a stability, while introduction of both gives a satisfactory evaluation of the stability of the atmospheric layers. Humidity of the atmosphere and phenomena of condensation tend to increase the wave-length on account of resulting density differences. R. S. R.

1544. Radiation Properties of Snow Layers. N. N. Kalitin. *Gerlands Beitr. z. Geophys.* 34. (*Köppen Band,* 3.) *pp.* 354–366, 1931.—The author deals with the penetration of solar and diffuse radiation through snow, the dependence of the time of melting of snow on the energy penetrating, and the amount of energy reaching plants under the snow. One vacuum pyranometer was exposed at the level of the ground and another on the surface of the snow to get the amounts of transmitted and incident radiation. The albedo of the snow cover was found for the total and short-wave radiation by a photoelectric method, while a spectrograph method was used to get the albedo for individual spectral regions. The results are tabulated, and curves illustrate the percentage of radiation transmitted for different snow thicknesses with and without allowance for the albedo of the surface. For wet snow the transmission is much decreased, especially for long-wave radiation. Calculations are also made for the heat balance for cloudless and cloudy days using Ångström's method. R. S. R.

1545. Infra-Red Radiation of the Atmosphere. J. Devaux. *Comptes Rendus,* 193. *pp.* 1207–1209, *Dec.* 7, 1931.—By means of a special spectrograph with rock-salt prisms and a radiomicrometer, the radiation of the zenith sky on the Pic du Midi (2860 m.) has been compared with that of a black body at known temperature. A wide but weak band at 8–14 μ and a narrow one at 5 μ are attributed to water vapour and perhaps carbon dioxide; a small secondary maximum at 10 μ is probably due to ozone at a moderate temperature. C. A. S.

1546. Conduction of Heat in Ocean Currents. H. Arakawa. *Inst. Marine Obs., Kobe, Japan, Mem.* 4. *pp.* 317–326, *Nov.,* 1931. *In English.*—The problem is treated on the basis of the equation $\partial(c\rho\theta)/\partial t = \mathrm{div}(k\,\mathrm{grad}\,\theta) - \mathrm{V}\partial(c\rho\theta)/\partial x$, on the assumption of a uniform flow of constant velocity V in a definite direction x, specific heat c, density ρ and conductivity k being constant; and allowing for periodic changes of temperature θ of both air and water, with a more detailed discussion of the case where the initial temperature is zero. C. A. S.

1547. Isostatic Tables for Reducing Gravity Observations on Airy's Hypothesis. W. Heiskanen. *Bull. géodésique, No.* 30. *pp.* 87–153, *April–May–June,* 1931. *In English.*—Using the author's former method, slightly modified by Lambert's results [see Abstract 765 (1931)], Hayford's zones (A to J or K being treated as one), and, as far as possible, Hayford and Bowie's tables, complete isostatic tables based on Airy's hypothesis have been calculated. The assumptions made are: compensation is complete, each separate zone floating on the sima layer; the compensating mass lies directly beneath mountain or ocean; the density of the earth's crust is 2·67, that of the sima layer 3·27; the thickness of the earth's crust for zero elevation is consecutively 40, 60, 80 and 100 km., and constant over all the earth. C. A. S.

1548. Gravity. A. Belluigi. *Gerlands Beitr. z. Geophys.* 2. 2–3. *pp.* 308–316, 1931. *In Italian.*—New formulæ for the calculation of gradient and curvature from observations with the Eötvös balance are given. The calculations are reconsidered for various assumptions as to the variation of density. W. A. R.

1549. Figure of the Earth. F. Hopfner. *Gerlands Beitr. z. Geophys. Supplementband I. pp.* 291–372, 1931.—After a critical treatment of the existing position, the author works out a new method, based on the potential theory, to determine the figure of the earth. No assumption is made as to the distribution of mass within the earth. W. A. R.

1550. Developments in Spherical Harmonic Functions of a Function whose Value is Given at each Point of the Continental Coast. True Representation. M. Brillouin. *Comptes Rendus,* 193. *pp.* 1360–1364, *Dec.* 28, 1931.—A mathematical solution is sought, in the case of a sphere on which an ocean is limited by one or more contours, for the general development in harmonic functions which have a value determined at each point by the contour. The results obtained are well adapted to numerical calculation and they are thus useful in some technical applications, especially aerodynamics. R. S. R.

1551. Horizontal Pendulum Seismograph. S. Higuchi. *Tohoku Univ., Sci. Reports,* 20. *pp.* 764–781, *Dec.,* 1931.—In the present paper the motion of the recording pin of the seismograph on the arrival of the seismic wave and the effects of it upon the seismogram are studied. For the purpose of practice, the actual form and dimension of the lever of Omori's seismograph were used. A method is proposed by which the characteristics of the incident seismic wave, that is, the frequency, time constant and amplitude of the wave, etc., can be determined. AUTHOR.

1552. Rapid Long Waves: Especially Somville's PL Waves. J. M. F. J. Coulomb. *Comptes Rendus,* 193. *pp.* 1211–1214, *Dec.* 7, 1931. —Assuming the PL waves [see Abstracts 1496 and 2610 (1931)] to be superficial, and that the underlying medium is unshakable with a Poisson coefficient 1/4, one of the roots of the equation for Rayleigh waves gives a velocity exactly double that of distortion waves (for S waves 3·1 km./sec.). This agrees well with the recorded velocity of PL waves, 5·95–6·4 km./sec. The most probable thickness of the underlying medium is 60 km. C. A. S.

1553. Potential Due to a Buried Spheroid. J. H. Webb. *Phys. Rev.* 38. *pp.* 2056–2067, *Dec.* 1, 1931.—A series solution of the problem dealing with the electrical potential due to a buried conducting spheroid under the influence of a surface point electrode is given. The problem is complicated by the boundary condition requiring the banishing of the normal derivative of potential on the surface of the half space. This condition is satisfied by placing an image spheroid in the upper half space. The problem then reduces to that of finding the potential due to two spheroids whose potentials react upon each other. The interaction of the potentials is handled analytically by means of a transformation theorem in spheroidal harmonics due to B. Datta. The method of solution employed leads to an infinite number of equations in an infinity of unknowns. An approximate method for solving these equations is given. It is believed by the author that the inverse distance formula in spheroidal harmonics, which is derived, is new. [See also Abstract 1832 (1931).] AUTHOR.

1554. Photometry of a Sunspot. H. Strebel. *Zeits. f. Astrophysik,* 3. *pp.* 270–278, *Oct.* 24, 1931.—The technical difficulties of photographic photometry of a sunspot umbra are discussed. The results of suitable copying processes applied to a large sunspot, June 27, 1926, are given with a series of microphotometric curves along parallel longitudinal lines. A number of regions of greater luminosity are shown to exist in the umbra and bridges are shown to extend far into the visual umbra. Tentative explanations of the phenomena are suggested. T. L. M.

1555. New Helio-Actinometer. Bordier. *Comptes Rendus,* 193. *pp.* 1044–1045, *Nov.* 23, 1931.—A quantimeter employing a solution of iodoform in chloroform has been utilised to determine the intensity of solar rays. Iodine is liberated by the action of the rays and this is compared, as regards its colour, with standard amounts of iodine in chloroform, when both solutions are contained in tubes of quartz glass, with a scale of tints numbered 1 to 12. The unit is termed a " heliometric unit " and the number of units corresponding to a standard exposure time of one minute is termed the " heliometric index." B. J. L.

1556. Central Intensity in the Fraunhofer Lines. A. Pannekoek. *K. Akad. Amsterdam, Proc.* 34. 10. *pp.* 1352–1364, 1931.—A study of the mutual influence of different wave-lengths on the intensity of the centre of a line. An atmosphere of constant density is assumed. The calculated intensities of the centre of the lines of calcium are still, however, rather smaller than those observed. G. C. McV.

1557. Apparent Increase in Solar Equatorial Rotational Velocity. J. Evershed. *Roy. Astron. Soc., M.N.* 92. *pp.* 105–107, *Dec.*, 1931.—Seven spectrograms of the sun's limbs in the region near H, K, and four in the region $\lambda = 4000$–4100, with Fe arc comparison and precautions for instrumental shift, using a device for rotating the sun's image, give a rotation of 2·015 km./sec., with some large unexplained variations. This is shown to agree with results of 1900–11; in the interval the value had been around 1·90 km./sec.; a suggested explanation based on variation in the level of absorption of the lines measured is given. T. L. M.

1558. Solar Corona Forms and their Origin. W. J. S. Lockyer. *Nature,* 128. *pp.* 784–787, *Nov.* 7, 1931.—The author divides coronal forms into 3 mean types, polar, intermediate and equatorial, and finds that the positions of sunspots do not justify their direct association with the actual coronal forms. He gives a diagram of the periodicities of solar phenomena, for sunspots, prominences, latitudes of sunspots, and of prominences and of the three types of corona, from 1860 to 1940 (the final ten years being predicted). He concludes that the coronal types are closely related to the prominences; that there seems little doubt that the " intermediate " type of corona takes two forms, one for waxing, one for waning solar activity. It is strongly suggested that an actual corona is really the sum total of a prolonged prominence action previous to its appearance at an eclipse. A. S. D. M.

1559. Photography of Solar Corona. B. Lyot and E. Esclangon. *Comptes Rendus,* 193. *pp.* 1169–1172, *Dec.* 7, 1931.—An account of the new method discovered by the author for photographing the solar corona, which makes it possible to obtain photographs at any time and not only during total eclipses. A description of one of the photographs is given. G. C. McV.

1560. Adiabatic Influences of Tides upon the Keplerian Motion of Two Gyroscopic Heavenly Bodies. G. Krall. *Accad. Lincei, Atti,* 14. *pp.* 270–276, *Oct.*, 1931.—Criticism and extension of the work of G. Darwin and T. Levi-Civita. The plane of the orbit places itself normal to the axes of the rotations into which the precessions degenerate, parallel to the invariant vectorial total moment of the quantity of motion of the system. A. D.

1561. Determination of Corrections to the Moon's Coordinates from the Solar Eclipse of Oct. 21, 1930. R. W. Marriott and J. H. Pitman. *Astron. J. No.* 963. *pp.* 129–132, *Nov.* 9, 1931.—The observations were made at Niafoou, Tonga; the photographs comprised four series of 8 plates each; these being carried out by two cameras of 38 in.

and 15 feet focal length respectively. The methods of observing and of reducing the results are given. The resultant corrections to the mean longitude and latitude of the moon are $5''\cdot 54$ and $-0''\cdot 25$ respectively. The correction to the mean longitude is close to that used ($5''\cdot 47$) by the Director of the American Ephemeris from observations of occultations.

A. S. D. M.

1562. Criterion for the Prediction of an Unknown Planet. E. W. Brown. *Roy. Astron. Soc., M.N.* 92. *pp.* 80–101, *Nov.*, 1931.—The use of the formula

$$\sin (x + \Delta x) + \sin (x - \Delta x) - 2 \sin x = -(4 \sin^2 \tfrac{1}{2}\Delta x) \sin x$$

or its more compact form $\Delta^2 \sin x + (4 \sin^2 \tfrac{1}{2}\Delta x) \sin x = 0$ for the determination of unknown periodicities from a continuous set of observations has been proposed on several occasions. The author indicates its use to eliminate from such a set, a periodic term with known period but unknown amplitude and phase, and then, the same transformation, applied to the perturbations in longitude of a planet produced by the attraction of an exterior planet, gives to the curve obtained by plotting these perturbations against the time a characteristic form which remains substantially the same over a considerable range of the ratio of the distances of the planets from the sun. The criterion is applied to (1) the prediction of Neptune by Adams and Leverrier, (2) the modern residuals in the longitude of Uranus, and (3) a check on the calculations of Nicholson and Mayall giving the perturbations of Neptune produced by Pluto. R. S. R.

1563. Property of the Equation Obtained when Equating to Zero the Distance of Two Planets which do not Meet in Two Real Points. M. Hamy. *Comptes Rendus*, 193. *pp.* 1357–1360, *Dec.* 28. 1931.—Putting $z = \mathrm{E}^{in}$, where E is the Napierian base of logarithms and n the eccentric anomaly of the planet the equation takes the form $e^2z^4 + (\mathrm{A} + \mathrm{B}i)z^3 + \mathrm{C}z^2 + (\mathrm{A} - \mathrm{B}i)z + e^2 = 0$, where e is the eccentricity and A, B and C depend upon the major axis, longitude of the perihelion, radius vector and true anomaly of one planet and on the mutual inclination of the orbits. A mathematical treatment is given for the roots of this equation. R. S. R.

1564. Recession of Extra-Galactic Nebulæ. A. S. Eddington. *Roy. Astron. Soc., M.N.* 92. *pp.* 3–7, *Nov.*, 1931.—A short account of the theory by which the author has deduced the radius of the Einstein space from which our actual space has expanded, on the basis of Dirac's wave-equation for an electron. This leads to a theoretical value for the velocity recession of nebulæ of an amount equal to 527·8 km./sec. The observed value is of the order of 500 km./sec. [See also Abstract 701 (1932).] G. C. McV.

1565. Astronomical Refraction. H. C. Plummer. *Roy. Astron. Soc., M.N.* 92. *pp.* 25–36, *Nov.*, 1931.—The general run of the refraction R for zenith distance ζ can be represented by $\mathrm{R} = \tan (\zeta^\circ - \zeta')$ or $\tan (1 - \frac{1}{60})\zeta^k$ with about the same accuracy as can be derived from a single homogeneous Cassini shell. Making no assumptions regarding atmospheric structure, general theory gives for moderate zenith distances $\mathrm{R} = \mathrm{A} \tan \zeta - \mathrm{B} \tan^3 \zeta$. For a class of assumed functional relations between μ and r including the Bouguer-Simpson hypothesis, the horizontal refraction, C, is $\sqrt{\mathrm{A}^3/\mathrm{B}}$

exactly or approximately. The observed value of C can be connected with the known values of A and B by attributing the refraction to two constituents in the atmosphere, but these cannot be identified with oxygen and nitrogen because the main effect occurs in the lower strata where the ratio of these gases is almost constant. Since the range of r in terms of the earth's radius is small, μ is implied to be a linear function of r and this allows for only one vertical gradient in μ and cannot explain adequately the facts of refraction. Dividing the atmosphere into two parts is convenient to allow for two gradients and is fairly confirmed by a comparison of the gradients derived from the refractions with the densities of the atmosphere up to 14 km. The result connects the form $\mathrm{R} = \mathrm{A} \tan \zeta - \mathrm{B} \tan^3 \zeta$, which is convenient for moderate zenith distances with the general form $\mathrm{R} = a_1 \tan \frac{1}{2}\{\tan^{-1}(b_1 \tan \zeta)\} + a_2 \tan \frac{1}{2}\{\tan^{-1}(b_2 \tan \zeta)\}$, which extends to the horizon. Values of the constants have been found giving good agreement with Bessel's mean refractions. R. S. R.

1566. Photographic Observations of Double Stars. W. M. Smart. *Roy. Astron. Soc., M.N.* 92. *pp.* 37–47, *Nov.*, 1931.—The author gives a list of 177 double stars measured on plates taken at Cambridge with the Sheepshanks equatorial, the plates having been made mostly for parallax and proper motion, and the earliest epoch being 1900. Despite the disadvantage that the plates were not specially taken for double-star work, the results seem comparable in accuracy with the best visual observations even for stars as close as 3″ or 4″. He describes the method employed to correct the measures when the double-star is not near the centre of the plate. A. S. D. M.

1567. Determination of Dynamical Parallaxes of Double Stars. W. S. Finsen. *Roy. Astron. Soc., M.N.* 92. *pp.* 47–52, *Nov.*, 1931.—H. N. Russell's notation is followed. The author adopts Hertzsprung's suggestion that use should be made of ψ, the angle between the radius vector and the direction of motion in the apparent orbit, which angle can be determined from the observations. Comstock's formula: $d_1 = s\sqrt[3]{\left[\left(\frac{d\theta}{dt}\right)^2(2\pi)^{-2}\right]}\sqrt[3]{[s \cdot \{a(1-e^2)\cos^2 r\}^{-1}]}$ is transformed into $d_1 = \sqrt[3]{(sw^2 \sin^2 \psi)(2\pi)^{-2}}\sqrt[3]{[\sin i \sin^2 \phi \,.\, \sin^2 \mathfrak{J}\,(2 - r/a)]^{-1}}$, which still remains Comstock's formula since the separation into factors is the same; but it now becomes evident that the two factors are not independent, and that the required average value of the second factor will vary with ψ. This explains the weakness of Comstock's formula. The author considers the Russell-Hertzsprung formula on this basis and finds that the changes in the $P(e)$ function have very little effect. Similarly he derives Jackson's formula directly from Comstock's formula. He discusses the case where, owing to lack of observation, only a small observed arc is available though the period is known. A. S. D. M.

1568. Effect of Proper Motion on Measures of Double Stars. A. Fletcher. *Roy. Astron. Soc., M.N.* 92. *pp.* 119–121, *Dec.*, 1931.—The effect of the proper motion of a binary system on the observed scale of the system is calculated. G. C. McV.

1569. Probable Eccentricities of Double Visual Stars whose Orbit is Unknown. D. Barbier. *Comptes Rendus*, 193. *pp.* 1393–1396, *Dec.* 28, 1931.—It was shown in an earlier paper that a function can be obtained for the distribution of eccentricities of a group of double stars of unknown orbits, but for which ω and σ can be calculated [see Abstract 3398 (1931)]. For some statistical researches it is convenient to know for each star its probable eccentricity, and the mathematical procedure is set out. This is applied to the values of ϵ^2 for 117 stars of known orbits, and it is shown that the theoretical eccentricity confirms the known fact of an increase of eccentricity with period. When applied to couples with unknown orbits the increase of eccentricity with spectral type is shown to be very close. R. S. R.

1570. Binary System 61 Cygni. A. Fletcher. *Roy. Astron. Soc., M.N.* 92. *pp.* 121–131, *Dec.*, 1931.—An extensive table of observed values of the apparent distance and position angle of the system is given for the period 1880 to 1931. A calculation of the elliptic elements of the orbit is carried out, the mass of the system being assumed to be that given by the mass-luminosity law. The period thus obtained is of the order of 1000 years and the eccentricity is fairly large. The arc of the orbit which has been observed is too short for an accurate determination of the mass from the elliptic elements. G. C. McV.

1571. Binary Systems. E. Sevin. *Comptes Rendus*, 193. *pp.* 1063–1066, *Nov.* 30, *and pp.* 1396–1398, *Dec.* 28, 1931.—For the case where one system is small compared with the other it is shown mathematically that the modification of the system resulting from the progressive destruction of the matter of the principal star differs according to whether the destruction is considered as a continuous phenomenon rigorously proportional to time or as a non-uniform phenomenon. The author further investigates the possible influence of complementary terms in the law of attraction for two large masses close together. General relations are set out for the motion of the centre of gravity of the system. Two special cases are first discussed which give rise to stability of the system. Next the general case is examined where the influence of complementary terms on the form of the orbit is also introduced. The motion is found to be Keplerian, the centre of gravity undergoing an acceleration of constant amount oriented in a direction turning with a uniform angular speed. This point describes a circumference with a fixed centre, and the major axes of the orbit are directed along the radii of this circumference. The progressive variations disappear and are displaced by a variation of long period. R. S. R.

1572. Apsidal Motion of Faint Eclipsing Binary (RU Monocerotis). H. Shapley. *Am. Acad., Proc.* 66. 12. *pp.* 469–477, *Nov.*, 1931.—Hitherto evidence of an advancing periastron has been found for Y Cygni only, but now photographic work at Harvard has shown that RU Monocerotis moves in an orbit of abnormally high eccentricity, with the line of apsides revolving (perhaps of the order of 1000 years). The longitude of periastron (ω) is given by $\cos\omega = \{\pi[2(t_2 - t_1) - P]\}\{2Pe\}^{-1}$, where t_1 and t_2 are the times of primary and secondary minima; the period of periastron revolution being measured by the periodicity of $t_2 - t_1$. It is difficult to evaluate the eccentricity (e) and ω separately, but Wendell had already shown that $d = t_2 - t_1 = 2\cdot 9\,(t_1 - t_2)$, and Dubiago and Martinoff had from visual observations called attention to the high eccentricity which is now, by the Harvard photographic work, found to be at least $0\cdot375$ or $2\frac{1}{2}$ times that of Y Cygni, the most eccentric short-period binary known. Tables and diagrams are given of 4 groups of photographic observations. The amplitudes at the two eclipses show that nearly central eclipse is observed of bodies essentially equal in size, luminosity, mass and surface brightness. These similarities should simplify the central concentration of matter within the stars. There is no evidence of ellipticity or reflection; at periastron the bodies are separated by less than 2 diameters, without visible effect on the total light, and this absence of periastron brightening indicates high central concentration. The radii of the stars are scarcely an eighth of the average distance between the centres. A. S. D. M.

1573. Omicron Herculis, Variable Star of very Small Amplitude. J. Dufay and R. Gindre. *Comptes Rendus*, 193. *pp*. 996–998, *Nov*. 23, 1931.—Omicron Herculis, first observed in 1877, has been given by various observers periods of 6·5, 6·27, 6·25894, 11·985, 10·327 and 7 days respectively; its light curve has sometimes been sinusoidal, but oftener of the β Lyræ type; the amplitude varying according to these observers from 0·2 to 0·5 magnitudes, but with a photoelectric cell photometer Becker could perceive none. The authors have used a visual surface photometer [see Abstract 2148 (1930)] giving a precision of nearly the hundredth of a magnitude, and 136 comparisons with the neighbouring ξ Herculis (between 1929 and 1931) show differences varying between the limits $+ 0·03$ and $+ 0·13$, attaining a maximum every 11 days. If the comparison star is constant, these variations agree well with a period of (nearly) 22 days and a light curve of the β Lyræ type. A diagram of the observations is given and a provisional ephemeris. The light curves correspond to that of an eclipsing binary, and the radial velocities, though few, indicate a variable speed. It is not possible to determine precisely the elements of the system. A. S. D. M.

1574. RU Aquarii. P. M. Ryves. *Roy. Astron. Soc., M.N.* 92. *pp*. 132–137, *Dec*., 1931.—The observations of this variable star made at Zaragoza in 1910–1911 give successive maxima at intervals of 69 days, and give no evidence for an unsymmetrical light curve of period 170 days. These results agree with the dates of photographic maxima on Harvard plates during 1901–1920. But the star appears to go through disturbed periods during which the periodic variation is in abeyance. Such a period occurred about 1922. G. C. McV.

1575. Mean Light-Curves of Long-Period Variable Stars. Part V. S. Ursæ Majoris. A. A. Nijland. *K. Akad. Amsterdam, Proc.* 34. 10. *pp*. 1372–1379, 1931. *In German.*—751 observations, 1904–1931, are discussed with the general result: Min., $2421689^d + 225^d E + 15^d \sin 10° (E + 6)$; Max. 111^d after Min.; Amplitude 4·12 magnitude. The residuals from a formula omitting the sine term are considerable and systematic. Irregularities in the shape of the curve at maximum are studied and explained by a disturbance about 70 days before maximum; the shape of the curve when cleared of this disturbance is fully discussed. [For Part IV see Abstract 778 (1932).] T. L. M.

1576. Luminosity Curve of Early B Stars. J. Schilt. *Roy. Astron. Soc., M.N.* 92. *pp*. 137–140, *Dec*., 1931.—The multiple maxima in the luminosity curve for B stars found by Gerasimovič [see Abstract 3384 (1931)] are shown not to be deducible from the material he employed. G. C. McV.

1577. Hydrogen Lines in Stellar Spectra. E. M. Lindsay. *Harvard Coll. Obs., Circ.* 368. [27 *pp.*], 1931.—Hogg's method for the photometric calibration of slit spectra by the multiplets of comparison spectra is applied to 37 Dominion Observatory plates of stars well distributed from type O to M; the lines used are Hβ, Hγ and Hδ, one being rejected in a few cases. Full details are given of the calibration of the microphotometric tracings against iron multiplets. Unsöld's formula does not fit the contours; the form $\log (I/I_0) = -k(\lambda - \lambda_0)^p$ is found satisfactory and the parameters vary with type; shown to be inconsistent with the results anticipated from Stark effect. The total absorption of the lines is deduced. In a discussion of sources of error, the instrumental (slit) contour is shown to have an effect within the limits of instrumental error; Eberhard effect must be avoided; and background effect may be very serious. The relation between absolute magnitude and total absorption is examined; lower limits to the number of atoms in various states are deduced; for late-type stars these are shown to be improbably high, suggesting departure from thermodynamic equilibrium. T. L. M.

1578. Behaviour of CH and CN Bands in Spectrum of δ Cephei. P. Swings. *Roy. Astron. Soc., M.N.* 92. *pp.* 140–147, *Dec.*, 1931.—Quantitative spectrophotometric details of these bands in the spectrum of the variable star 27 δ Cephei are given. The bands are both absent at maximum of light, and are at their maximum at phase 0·70 — 0·75. A calculation of ratios of the numbers of CH molecules in the different phases is given, which is in close agreement with the values computed from the equation of dissociative equilibrium of CH. Thus the temperature of the star, deduced from these bands, varies between 4600° and 4950° C. G. C. McV.

1579. Galactic Rotation Effect in Late-Type Stars. R. O. Redman. *Roy. Astron. Soc., M.N.* 92. *pp.* 107–115, *Dec.*, 1931.—Single low-dispersion spectrographs of 400 type K stars of visual magnitude 7·0 to 7·5 within 10° of the galactic equator. Instrumental errors are discussed, especially a systematic error in the derived velocities determined from standard stars, which remains incompletely explained, but is too small to affect the discussion. The p.e. per plate is 3·6 km./sec. from 38 stars measured more than once. Systematic test plates are recommended. The solution for the apex of solar motion agrees very well with previous work (280° + 35°). The inclusion of the galactic rotation harmonic terms gives little improvement; the result here is " entirely negative "; previous work is discussed and the limitations of the method fully stated. T. L. M.

1580. Photometric Observations of the Milky Way and Zodiacal Light. K. Graff. *Akad. Wiss. Wien, Ber.* 140. 2*a*. 9–10. *pp.* 739–742, 1931.—In Majorca, during the winter of 1930–31, the Zodiacal Light was very conspicuous, and was seen as a band right across the sky. Its brightness at different distances in longitude from the sun was compared with that of certain regions in the Milky Way, and the result is shown in a curve. The brightness is greater, and the curve steeper, than that found by Fessenkoff at Nice and Meudon. It is evident that the light is an astronomical, not a terrestrial phenomenon, for it follows exactly the sun's daily and yearly movements, and lies always in the ecliptic. M. A. E.

LIGHT.

1581. Transparency in Silver Films. A. Jagersberger. *Akad. Wiss. Wien, Ber.* 140. 2*a*. 9–10. *pp*. 753–771, 1931.—Films of silver are deposited by kathode methods (described) and their thickness measured by various methods (described). The transparencies of the films are calculated by a formula due to Goldschmidt and compared with microphotometer measurements; the observed discrepancies are discussed. Optical constants are found which, on being introduced into the formula, annul these discrepancies. A. D.

1582. Comparison of Wright's Data on Equivalent Colour Stimuli with the O.S.A. Data. D. B. Judd. *J.O.S.A.* 21. *pp*. 699–728, *Nov*., 1931.—The standard of colour "excitation" curves used widely in America is based on data obtained by only three observers. New curves, obtained from observations made on ten subjects by Wright, using modern methods, are compared with the old standard and the advantage of substituting them is discussed. Wright's experimental results seem to point to a somewhat heavier macular pigmentation; this is in agreement with Sachs' data on pigmentation. There is no great balance in favour of the adoption of the new standard, especially if it is possible that a much better one may shortly be discovered. H. M. B.

1583. Transformation of the Trichromatic Coordinates of a Colour into Ostwald Coefficients. M. Richter. *Zeits. f. techn. Physik*, 12. 11*a*. *pp*. 582–587, 1931.—Reference is made to the faulty technique of measurement used by Ostwald [see Abstract 1853 (1931)] and the resulting insufficiency of the formulæ of transformation based on them. The author deduces his formulæ by using Luther's system of pigment colours. The formulæ are applied to derive from Ostwald's condition the well-known fact that the shadow series are series of equal saturation. The constants required for the transformation are described and determined. H. L. B.

1584. Measurement of Reflection Factors in the Ultra-Violet. A. H. Taylor. *J.O.S.A.* 21. *pp*. 776–784, *Dec*., 1931.—As many materials diffuse reflected radiation to some extent, it is desirable to use some method of measurement which integrates the reflected radiation. The method described is an absolute method employing a sphere reflectometer in a manner similar to that described earlier [see Abstract 412 (1921)]. The source of light is a Mazda Sunlight lamp with a quartz bulb; as a monochromator a Hilger quartz spectrograph equipped with a photoelectric cell is employed. A two-stage amplifier is used in conjunction with the cell. A study is made of the spectral reflection curves for magnesium oxide and carbonate, and acid-etched aluminium and zinc. A new method for the measurement of relative reflection-factors for materials used in dual-purpose lighting is also described. The spectral sensitivity of this method is such that the reflected radiation is appraised approximately in accordance with its erythemal effectiveness. A. H.

1585. Refractivities and Optical Dispersions of Methane and its Substituted Chlorine Derivatives. G. W. Brindley and H. Lowery. *Phil. Mag.* 12. *pp*. 945–954, *Nov*., 1931.—The dispersion results for these substances in the gaseous state are in each case represented by a single-term formula of the Sellmeier type, within the limits of experimental error. It is shown that for $CHCl_3$, CH_2Cl_2 and CH_3Cl the refractivities can be explained to within 1 % by assuming a certain refractivity for each of the C–H and C–Cl linkages, which are presumably homopolar. These are derived from the measurements on CH_4 and CCl_4. It appears that the probabilities of excitation of electrons in the chlorine atom (or ion) in HCl, CCl_4, $CHCl_3$, etc., are practically the same. This is also true for the C–H linkage in CH_4 and its derivatives. It is shown that the results imply that the four C–H linkages in CH_4 are equal; this is discussed in relation to London's theory of homopolar valence. H. N. A.

1586. Determination of Refractive Indices by Total Reflection. A. Biot. *Ann. Soc. Sci. de Bruxelles*, **51.** *pp.* **185–191**, *Dec.*, **1931.**—In instruments for measuring refractive indices by the method of total reflection, on account of the curvature of the limit of total reflection, the perpendicularity of the axis of observation to the prism faces must be true to 5′ in order to avoid errors above 3″ in the measured angle of emergence. If the incident light is cut down to a very fine pencil, the limit has the appearance of a spectral line, and under these conditions the accuracy obtainable is a maximum. An investigation of the diffraction phenomena in the neighbourhood of the limit shows that an error in indices of 1 or 2 units in the fifth decimal is to be expected. The error depends on the intensity of the light source, and greater accuracy cannot be obtained by this method. C. B. A.

1587. Optically-Active Spiro-5 : 5-Dihydantoins. W. J. Pope and J. B. Whitworth. *Roy. Soc., Proc.* **134.** *pp.* **357–371**, *Dec.* **2, 1931.**—A simple carbospirane, *spiro*-5 : 5-dihydantoin, has been resolved into optically-active components by a method involving the separation of mono-brucine *l*-*spiro*-5 : 5-dihydantoin and di-brucine *d*-*spiro*-5 : 5-dihydantoin in the crystalline state. The externally compensated substance is shown to be a racemic compound. The rotatory dispersions in neutral and alkaline solvents show that the compound exists in two or more tautomeric forms. A new type is thus indicated, the molecular component –NH.CO.NH– existing in an enolic as well as a ketonic form. Evidence is also obtained that the 1 : 9-diacidyl-derivatives of the dihydantoin also undergo tautomeric change. The crystalline racemic dihydantoin has an abnormally high density which is correlated with its low solubility and high melting-point. C. B. A.

1588. Action of Boric Acid and Borates on the Rotatory Power of Glucose, Galactose and Fructose. E. Darmois and (Miss) R. Peyroux. *Comptes Rendus*, **193.** *pp.* **1182–1185**, *Dec.* **7, 1931.**—The authors deal mainly with borates which contain more sodium than ordinary borax, and find that the effect on the rotatory power (α) is greatly increased with these salts. Using $NaBO_2$ (α) even becomes negative showing that there is a lævogyratory compound of d-glucose and borate. The rate at which the compound is formed depends on the temperature, and the value of (α) decreases to a minimum during a certain time interval. Strange to say (α) then begins to increase. The problem is dealt with in detail for glucose, galactose and lævulose. H. N. A.

1589. Sensitive Method for Measuring Small Ellipticities of Polarised Light. G. Szivessy and A. Dierkesmann. *Ann. d. Physik*, **11. 8.** *pp.* **949–984**, *Dec.* **8, 1931.**—A simple and very sensitive method of determining the azimuth ϕ and ellipticity (tan ψ) of monochromatic parallel polarised light of weak ellipticity is described. The azimuth is determined by means of a rotatable analyser in front of which a thin Soleil double plate is placed. For measuring the ellipticity, the Soleil plate is replaced by a thin doubly-refracting plate, of known phase difference Δ, which is carried on a divided circle, and which covers only half the field. If Δ lies between 0 and $\frac{\pi}{2}$ and is greater than 4ψ, on rotation of this "half-shadow" plate eight extinction positions are obtained. In four of these (two pairs of perpendicular settings), the vibration directions of the half-shadow plate are parallel to the axes of the ellipse; the other four lie symmetrically about the line of bisection of the two quadrants defined by the first four. If β is the angle between this and the nearest of the second four settings, $\tan 2\psi = \sin|2\beta| \tan\frac{\Delta}{2}$. The sense of the elliptic vibration can also be determined. The accuracy obtainable is: ϕ, to a fraction of a minute; ψ, of the order of $5 \times 10^{-5} \times 2\pi$, to 0·2 to 0·3 %. C. B. A.

1590. Distribution of Strong A.C. Fields in the Nitrobenzene Kerr Cell and Validity of Kerr's Law for Nitrobenzene in these Fields. F. Hehlgans. *Phys. Zeits.* 32. *pp.* 951–957, *Dec.* 1, *and pp.* 971–974, *Dec.* 15, 1931.—Observations made in alternating fields up to $1 \cdot 5 \times 10^5$ volts/cm., over a period of several hours, show that with highly purified nitrobenzene the field distribution in a Kerr cell is independent of the voltage and of the phase. With impure nitrobenzene no such homogeneity is observed. The inhomogeneities increase with the field strength and follow the oscillations of the applied voltage, although the "integrated" observations showed a pseudo-homogeneity. The purity of the nitrobenzene is therefore also of great importance when alternating, instead of constant, voltages are applied to the cell. Using the highly purified nitrobenzene it is shown that the Kerr law still applies in alternating fields over the whole range of voltages used. [See also Abstracts 393 and 801 (1932).] C. B. A.

1591. Diffraction Fringes Obtained with a System of Equally Spaced Rings. F. Scandone. *N. Cimento,* 8. *pp.* 338–351, *Nov.,* 1931.—This paper follows another by the same author [see Abstract 3421 (1931)] on the fringes obtained by aberration of light waves under various conditions. Here a system of rings is placed symmetrically on the axis of a pencil of light rays under aberration. The case for a single aberration is dealt with mathematically. If the total aberration is present, the parameters necessary for the coefficients of aberration can be obtained from the interferogram. H. M. B.

1592. Comparison Image Micrometer. F. J. Hargreaves. *Roy. Astron. Soc., M.N.* 92. *pp.* 72–80, *Nov.,* 1931, *and pp.* 453–455, *March,* 1932. —The instrument described is used to measure the separations and position angles of double stars, and possesses certain advantages over the filar micrometer. It is less subject to systematic error and personal idiosyncrasy, and gives more consistent results. The instrument is such that the images of two artificial stars are projected into the field of view of the telescope, side by side with the images to be measured, and the distance between the artificial stars is varied until the separation of their images appears the same as that of the images of the real stars. The artificial stars are mounted on a rotatable carrier so that the line joining their images can be placed parallel to the line joining the real star images, thus enabling position angles to be measured, and there is provision for varying the brightness and colour of both artificial stars independently so that their images match those of the real stars. The instrument bears a superficial resemblance to certain range-finders and gun-sights in which the image of a graticule is formed in the focus of a telescope, but sources of error are avoided here. A list of measurements with 14 stars shows its increased advantage. R. S. R.

1593. Constant Monochromatic Spark Illumination. G. S. Forbes and F. P. Brackett, Jr. *Am. Chem. Soc., J.* 53. *pp.* 3973–3976, *Nov.*, 1931.—Illumination automatically constant over long periods is obtained from a spark struck between adjacent edges of two square bars moving in horizontal planes at right angles to each other. Conduction and radiation of heat are so rapid that erosion is at a minimum. A simplified method of following total energy at the exit slit of a monochromator is suggested and proved to be accurate. The monochromatic energies obtainable, under specified conditions, from Zn, Cd and Al sparks, are listed at several wave-lengths. F. S.

1594. Laminary Reflection Gratings for Infra-Red. C. H. Cartwright. *J.O.S.A.* 21. *pp.* 785–791, *Dec.*, 1931.—The theory of distribution of intensity among the orders of spectrum from a laminary grating is given. Five ways of preparing such gratings are then outlined—cutting in deposited layers of silver, cadmium or wax, photo-etching or direct photography. An echelette grating made from a pile of glass plates is also described. F. S.

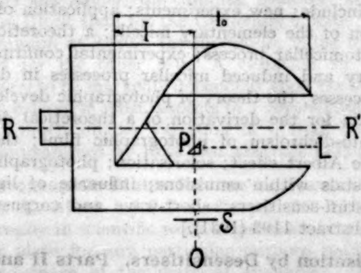
1595. Maximum Aperture Ratio of Simple Lenses. H. R. Schulz. *Zeits. f. Physik*, 73. 7–8. *pp.* 538–540, *Dec.* 30, 1931.—Taking into account possible total reflections at the second surface, two limiting values are found for the aperture ratios of simple lenses which lie in the neighbourhood of unity. Lenses of maximum efficiency fall within these limiting values. H. H. Ho.

1596. Focal Lengths of Diverging Lenses. H. Greinacher. *Helv. Phys. Acta*, 4–6. *pp.* 428–431, 1931. *In German.*—A simple method of measuring the focal length of a diverging lens is described, in which the virtual image of a source of light is located by using a small plane mirror in front of the lens at 45° to the axis of the lens, and putting another source out to the side. The images, often two sources, are then brought into coincidence by the no-parallax method. The image is then as far behind the plane-mirror as the source is in front of it. A modification is described in which a " collimated star "' is used as an object for the lens, so that the distance measured as above is the focal length direct. A. C. M.

1597. Relationship between Microscope and Telescope. H. Greinacher. *Helv. Phys. Acta*, 4–6. *pp.* 432–436, 1931. *In German.*—The relationship between the two instruments is brought out by considering the transformation of a microscope into a telescope by the addition of a convergent or divergent lens in front of the objective. Thus a microscope with micro-camera attachment can be used as a camera with telephoto-lens. The magnification formula is calculated for a telescope by reference to a microscope system. A. C. M.

1598. New Polarising System for Spectrophotometers. J. H. Dowell. *Journ. Sci. Instruments*, 8. *pp.* 382–384, *Dec.*, 1931.—An improved form of nicol prism in which scattered light is much reduced is described. An improved polarising system for spectrophotometers is described consisting of three nicols in tandem, the first and last being stationary and arranged to transmit light polarised in the same plane, the second prism being arranged to rotate. In such a system it is shown that the ratio of intensity follows the law $I_1/I_2 = \tan^4 \theta$. The theoretical advantages of the system as compared with the usual system consisting of one fixed and one rotating nicol in which the ratio of intensity follows the $\tan^2 \theta$ law are also discussed. AUTHOR.

1599. Cylindrical Rotating-Sector Photometer. F. L. Dunn. *Rev. Sci. Instruments*, 2. *pp.* 807–809, *Dec.*, 1931.—The cylindrical sector (shown in fig.) resembles a core drill with two teeth. The light to be examined passes by the path LP along the axis of the cylinder, and is then reflected radially along PO by the prism P. By varying the position of P along the axis, a continuous range of transmissions from 0 to 100 % is available. G. E. B.



1600. Photoelectric Methods for Testing Camera Shutters. H. J. Reich and G. S. Marvin. *Rev. Sci. Instruments*, 2. *pp.* 814–817, *Dec.*, 1931.—Light from a suitable source passes through the shutter, and is received in a photoelectric cell connected to a suitable valve relay, in the output of which is an oscillograph element. The operation of the shutter is recorded on the oscillograph record, which shews (1) the time of exposure, (2) the light-efficiency of the shutter and (3) the speed of opening and closing. G. E. B.

1601. Arc Lamps in Kinematography. T. T. Baker. *El. Rev.* 109. *p.* 696, *Nov.* 6, 1931.—This paper reviews some of the reasons why the arc lamp is necessary as a supplementary aid to the incandescent lamp in kinematography. The incandescent lamp fails to give the modelling required by the producer. The whiteness of the arc flame is of paramount importance in the projection of coloured films; in the case of projection the maximum amount of white light is wanted for a given amount of current consumption. The sensitiveness to white (incandescent) light of an ordinary photographic film and of a film chemically sensitised to colour is illustrated in the paper by curves. Spectroscopic control is shown to be rapidly becoming a necessity, since the advances recently made in natural colour kinematography at home and abroad demand a very high standard of " whiteness." H. H. Ho.

1602. Preparation of Colour Photographs by Means of the Herschel Effect. Y. Kamada. *Phot. Indust.* 29. *pp.* 1264–1266, *Nov.* 25, 1931.—Experiments are described which show that the Herschel effect is not only caused by red and orange rays, but also by infra-red, yellow, green and to a certain extent blue rays. Plates are developed by application of the Herschel effect whereby direct positive photographs are produced in the camera. The paper is illustrated by diagrams and photographic examples. H. H. Ho.

1603. Micelle Theory of the Latent Image. Part II. F. Weigert. *Zeits. f. wiss. Phot.* 30. 8. *pp.* 217–240, *Nov.*, 1931.—In the present paper, the author claims that his micellar theory is not only suitable for the qualitative and quantitative explanation of the numerous manifold photodichroic effects, but also enables a theoretical interpretation of the important Albert effect and other well-known photographic phenomena. The various sections include: new experiments; application of the equivalent law and definition of the elementary micelle; a theoretical treatment of the primary photomicellar process; experimental confirmation of photochlorides; primary and induced micellar processes in dyestuffs and in photographic processes; the theory of photographic development; a short survey of the data for the derivation of a theoretical darkening curve; the induced photo-dichroism of photographic films; the photolysis of silver halides; the Albert effect; solarisation; photographic properties of silver halide crystals within emulsions; influence of light of different colours and dyestuff-sensitisers; short-wave and corpuscular radiation. [For Part I see Abstract 1193 (1931).] H. H. Ho.

1604. Sensitisation by Desensitisers. Parts II and III. Lüppo-Cramer. *Zeits. f. wiss. Phot.* 30. 9. *pp.* 242–254, *Nov.*, 1931.—In these papers [see also Abstract 3052 (1931)] the author shows that the exceedingly active blue-desensitiser capri blue also influences the degree of dispersion of the silver nuclei, which arise in the ripening process, in a manner favourable for photosensitivity. H. H. Ho.

1605. Precautions in Practical Sensitometry. G. S. Moore. *Phot. J.* 71. *pp.* 403–412, *Nov.*, 1931.—Discusses the results of L. A. Jones and his collaborators [see Abstracts 722 and 1812 (1926)] pointing out that no satisfactory intensity scale instrument is yet available. Considers the difficulties in the way of constructing such an instrument, and indicates the advantages it would have over the present method of exposure to a time scale. A. H.

1606. Sensitometry in the Modern Film Laboratory. C. R. Keith. *Phot. J.* 71. *pp.* 412–415; *Disc.*, 415–417, *Nov.*, 1931.—The importance of sensitometry, especially with reference to sound films, is stressed. Simple sensitometers and densitometers as used in film laboratories are described and illustrated. The precautions necessary in dealing with the negative sound track density are indicated. In the *Discussion*, **S. O. Rawling** pointed out that owing to the difference in the times of exposure the γ values obtained in actual recording must differ markedly from those obtained in the sensitometer. The author agreed and discussed this effect at length. **A. Pereira** stated that he found that quite small variations in the density of the developed sound track caused important variations in the quality of the reproduction of the higher frequencies. **S. Read** asked whether the success of the sound record de-

pended upon the absolute density. The author replied that it was necessary to keep working upon the same portion of the H. and D. curve.
A. H.

1607. Characteristics of Panchromatic Plates. N. G. Perrakis. *J. de Physique et le Radium*, 2. *pp.* 341–352, *Nov.*, 1931.—A study is made of the characteristics of Guilleminot and Ilford panchromatic plates as employed by the Strasbourg Observatory for the eclipse of May 9, 1929. As source a tungsten filament lamp is employed, careful control being maintained over the filament temperature so that during 40 hours' continuous running the filament intensity varied by less than 1 %. The intensity of the source is varied by altering the distance of the lamp from the spectrograph slit, and exposures of 30 min. are employed (thus the exposures are of the order generally employed in astrophysical observations). The results show that both plates exhibit sensitivity maxima at λ6400, λ5750 and λ4650; the minima, however, are much less pronounced for the Ilford than for the Guilleminot plate. Both plates show γ to be a maximum at λ6800, the maximum value for the Ilford plate being 4·4 and for the other 5·0. A variation in the nature of the developer shows γ to be markedly dependent upon the developer employed. The two plates behave in most respects in a very similar fashion, and they both exhibit a much smaller variation in γ than did the Kodak panchromatic plate examined by Ross [see Abstract 1412 (1920).] A. H.

1608. Photographic Plates for use in Spectroscopy and Astronomy. C. E. K. Mees. *J.O.S.A.* 21. *pp.* 753–775, *Dec.*, 1931.—The use of photography in scientific work is increasing rapidly, and the choice of the correct plate for any particular purpose requires a considerable amount of knowledge of the material available. This paper provides specific information as to the characteristics of plates made by the Eastman Kodak Co. In the first part a discussion is given of the sensitometric characteristics of photographic plates in general; the subject of graininess is dealt with, and microdensitometer tracings showing the graininess of various Eastman plates are reproduced. The second part deals with the types of plates available for use in the different regions of the spectrum, the red and infra-red regions being covered in great detail. A New-Series infra-red sensitive plate is described having more than 10 times the sensitivity of neocyanine plates at λ9000. New methods for hypersensitising red-sensitive plates, and for sensitising plates to the ultraviolet are also described. A. H.

1609. Red Fluorescence of Glass. L. Bruninghaus. *J. de Physique et le Radium*, 2. *pp.* 398–402, *Dec.*, 1931.—In a recent paper [see Abstract 1531 (1931)] Peters describes the red fluorescence which is occasionally observed when an electric discharge passes through a vacuum tube containing rarefied gas, especially oxygen. In order to explain the fact that after a long time (70 hours) the red colour gives place to a green, Peters assumes that the group SiO_2 undergoes a modification of crystallographic order. The present paper is an attempt to give a more satisfactory and complete explanation of the phenomena observed. It is shown that every fluorescent and phosphorescent body consists of a solution (solid or liquid) of a body playing the active rôle in the emission of light, and designated by the author under the name of "phosphorogene," in a diluent whose rôle is to ensure a dissemination of the molecules of the phosphorogene. It appears probable that the substance in question is a composition of manganese, probably an oxide. At a minimum of oxidation this gives a green fluorescence, in conformity with the green colour of the protoxide of manganese. When the tube has been cleared of its occluded gas and washed with oxygen a higher alkaline oxide is obtained which produces a red kathodic fluorescence. Thus after the prolonged action of kathode rays, as described by Peters, a slow reduction of the alkaline oxide to the lower oxide takes place, and the red colour changes to green. T. B.

1610. Fluorescence in the Visible Region Excited in Fluorspar by Schumann Rays. E. Lau and O. Reichenheim. *Ann. d. Physik,* 12. 1. *pp.* 69–70, *Dec.* 22, 1931. *From the Reichsanstalt.*—Fluorspar excited by the ultra-violet emission of gases in a discharge tube showed an intense green fluorescence and a phosphorescence which lasted half an hour. The surface layer only is affected, becoming coloured blue and being removable by washing with water or by short treatment with HCl. The spectrum consists of 3 band pairs at 585 and 575, at 479 and 472 and at 551 and 538 $\mu\mu$. The same spectrum is seen under kathode rays. J. E.

1611. D-Line Fluorescence of Sodium at High Pressures. A. Jablónski and P. Pringsheim. *Zeits. f. Physik,* 73. 5–6. *pp.* 281–288, *Dec.* 10, 1931.—The polarisation of the fluorescence of Na vapour excited by yellow light is unaffected by magnetic fields of 80 gauss, whether the field is parallel to the direction of observation or at right angles to it. An apparent effect in the first case is found to be due to a Faraday effect on the Na vapour through which the fluorescent light passes. Examination of the light with a Lummer-Gehrcke plate shows that the line width must be less than 2 Å. Photographs with a grating show that the fluorescent lines are shifted from the normal D positions by 0·5 Å. and very little broadened. An attempt to measure the work of dissociation of the hypothetical Na molecules was not successful. It is not yet clear whether the radiation is scattered or fluorescent. [See also Abstract 3814 (1931).] J. E.

1612. Luminous Phenomena Caused by the Rolling of Amalgams on Glass. Duffieux and G. Trotel. *Comptes Rendus,* 193. *pp.* 1405–1407, *Dec.* 28, 1931.—The amalgam was placed in a pyrex glass globe, which was carefully cleaned, evacuated and rotated by a motor. Zn, Cd and Na amalgams were experimented with. The phenomena in each case differed to some extent from those observed with pure mercury. The D-line is given out at one point in the luminescence produced by Na amalgam, but no Cd lines were seen with Cd amalgam, and apparently no Zn lines with Zn amalgam. H. N. A.

1613. Spectral Analysis with Glass Prisms. W. Kraemer. *Zeits. f. Elektrochem.* 37. *pp.* 862–874, *Dec.,* 1931.—Most of the lines which have been regarded as suitable for analytical purposes lie in the ultra-violet; but the author has investigated a number of elements with a special direct-vision spectroscope, using glass prisms, and gives tables containing the wave-lengths of suitable lines, which can be measured with it, for a number of different elements. The condensed spark method was employed, and a number of special steels, containing such elements as Ca, Cu, Mn, Si, Ti, Zr, P, Cr, Ni, Co, As, Al, C, Mo, W, V and S were examined. H. N. A.

1614. High Resolution in the Infra-Red. J. D. Hardy. *Phys. Rev.* 38. *pp.* 2162–2167, *Dec.* 15, 1931.—An instrument is described which is capable of giving an experimental resolving power of ten thousand in the near infra-red region. With this instrument several of the infra-red lines of HeI have been examined and their components resolved. The exceedingly faint lines of the NeI spectrum lying between 1 μ and 2 μ have been discovered and their wave-lengths measured. AUTHOR.

1615. Molecular Spectra and Molecular Structure. H. Deslandres. *Comptes Rendus*, 193. *pp.* 1364–1368, *Dec.* 28, 1931.—The paper forms a continuation of earlier work on this subject [see Abstract 3825 (1931)]. Molecular spectra in the luminous and ultra-violet regions show three series of frequencies which are attributed to (1) molecular rotation, (2) actions at the centre of the nucleus and (3) changes of molecular configuration. Formulæ have been deduced for the infra-red region. The author doubts (1). He considers that in a molecular binary displacement of atomic nuclei can give rise to four types of radiation without modifying the general configuration, *viz.*, mutual action of the nuclei, each nucleus acting on the electrons of the other and mutual action of electron groups. In a table are set out for H_2, C (crystalline), N_2, O_2, Cl_2, HCl and HBr the known infra-red frequency of Raman rays, the number of electrons and the ring acting. The Raman frequencies are in good accord with the formula and with electron rings. A molecular frequency being given, whole numbers are sought to reproduce the frequency and useful indications can be drawn regarding the molecular structure or modifications imposed by radiation. R. S. R.

1616. Absorption Spectrum of Chlorine Dioxide. H. C. Urey and Helen Johnston. *Phys. Rev.* 38. *pp.* 2131–2152, *Dec.* 15, 1932.—The wave-lengths of 134 absorption bands were measured, using large quartz spectrographs, and are tabulated for comparison with Finkelnburg and Schumacher and Goodeve and Stein's results. Five vibrational levels of the normal electronic state have been found, while the levels of the excited state can be described by two vibrational quantum numbers. Formulæ are given for the bands and their isotope separations. The shape of the molecule has been calculated from Bjerrum's formulæ, all solutions but one being excluded by the isotope effect. The intensity distribution is consistent with the extension of the Franck-Condon principle to polyatomic molecules. F. S.

1617. Spectra of Gases Appearing in Early Stages of the Spark. E. Matuyama. *J.O.S.A.* 21. *pp.* 792–799, *Dec.*, 1931.—An electro-optical shutter as described by Beams and Lawrence was used to isolate light from the early stage of the spark. Spectrum photographs of sparks in air, oxygen and hydrogen are compared when taken through the shutter and also without it. Broadening and shift of the lines observed in the early stages of the spark are attributed to the Stark effect of the inter-ionic fields. F. S.

1618. Arc Spectrum of Gold. J. C. McLennan and A. B. McLay. *Roy. Soc., Proc.* 134. *pp.* 35–41, *Nov.* 3, 1931.—Thorsen's analysis is discussed in relation to subsequent measurements of this spectrum and of those of HgII and TlIII. Tables of lines which have been classified are given. F. S.

1619. Spark Spectrum of Mercury, HgII. J. C. McLennan, A. B. McLay and M. F. Crawford. *Roy. Soc., Proc.* 134. *pp.* 41–47, *Nov.* 3, 1931. The previous work of Paschen and Naudé is reviewed and the spectrum further analysed, all classified lines being tabulated. F. S.

1620. Band Spectrum of Mercury Hydride. R. Rydberg. *Zeits. f. Physik,* 73. 1–2. *pp.* 74–86, *Nov.* 24, 1931.—The activated conditions have been investigated anew, whereby ${}^2\Pi_{1/2}$ up to $v = 3$ and ${}^2\Pi_{3/2}$ up to $v = 6$ are traced. Two new ${}^2\Sigma \rightarrow {}^2\Sigma$ bands were analysed. Some anomalous intensity relations, especially the appearance of Q derivatives in ${}^2\Sigma \rightarrow {}^2\Sigma$, were observed. The dissociation limits are discussed. A mutual interference between two terms in the ${}^2\Pi$ condition in agreement with the theory of Kronig is dealt with. J. J. S.

1621. Excitation of the Arc Spectrum of Nitrogen. K. R. More and O. E. Anderson. *Phys. Rev.* 38. *pp.* 1995–1999, *Dec.* 1, 1931. —The arc spectrum of nitrogen has been excited with low-voltage arcs in mixtures of argon and nitrogen. A comparison of the intensities of the lines showed that the strong N I lines were as intense as the moderately strong argon lines. The excitation takes place probably in two steps, the first being the dissociation of the nitrogen molecules into normal and metastable nitrogen atoms by collisions with metastable argon atoms, and the second being the excitation of the metastable nitrogen atoms by collisions with metastable argon atoms. AUTHORS.

1622. Emission Spectrum of Carbon Dioxide. H. D. Smyth. *Phys. Rev.* 38. *pp.* 2000–2015, *Dec.* 1, 1931.—The emission spectrum of carbon dioxide has been studied by the electron beam excitation method used by Smyth and Arnott. The whole range of the spectrum from 6500 to 1400 has been examined and only the bands reported by Fox, Duffendack and Barker in the region from 2700 to 5000 have been observed. A particular effort was made to get in emission the extreme ultra-violet bands reported by Leifson in absorption, but it was unsuccessful. The "second negative bands of carbon" are shown to be probably identical with parts of the Fox, Duffendack and Barker system. This system of some 200 bands is partially analysed into fifteen progressions of band heads given by the formula $\nu = 26{,}271 - \nu_x + 1136\cdot85v - 1\cdot85v^2$, where ν_x takes on a particular value for each progression and $v = 0, 1 \ldots 10$. About 100 bands fit into this arrangement. This empirical analysis is shown to be consistent with a scheme of energy levels involving two normal modes of vibration (ν_1' and ν_2') in the upper electronic state and two (ν_1'' and ν_3'') in the lower electronic state. The $2\nu_2'$ state is split into two separated by 166 cm.$^{-1}$; this and the values of the frequencies are consistent with Dennison's and Barker and Martin's analysis of the infra-red spectrum, but since the spectrum here analysed presumably does not involve the normal state the frequencies are numerically different. AUTHOR.

1623. Colour of the Light from H.F. Discharges in Helium. J. S. Townsend and S. P. McCallum. *Phil. Mag.* 12. *pp.* 1168–1175, *Dec.*, 1931.—The colour of the light emitted by helium when subjected to h.f. discharges varies with the pressure of the gas, the p.d. across the electrodes, the distance between the electrodes, and the shape and size of the electrodes. Some of the variations are caused by the appearance of bands in addition to the usual lines of the spectrum, and others by the changes of the relative intensities of the lines; the bands cause a purple glow, whilst the intensity changes cause the production of a brilliant green colour. The conditions under which each type of colour is produced are described in detail. H. F. G.

1624. Electronic Transitions between Shells of Rare Earth Ions in Crystals. S. Freed. *Phys. Rev.* 38. *pp.* 2122–2130, *Dec.* 15, 1931.—It is shown that ultra-violet absorption by crystals of salts of the rare earths must correspond to a transition from the 4*f* shell to virtual outer shells or to the lattice. This theory is tested experimentally, using single crystals of Ce salts at various temperatures and also crystals containing Ce+++ and La+++ ions. Three new structureless bands are discovered, agreeing with the theory. A previous conclusion, that the lines of the rare earths are in general associated with inner quantum states, is supported. Bands similar to those of Ce+++ are found for Nd+++, but they begin further in the ultra-violet. It is expected that the bands for Pr+++ begin near 2100 Å. N. D.

1625. Rotational Structure of the Red Bands of Potassium. F. W. Loomis. *Phys. Rev.* 38. *pp.* 2153–2161, *Dec.* 15, 1931.—A rotational analysis has been made of four bands of the red system of K_2 which had been photographed under high dispersion. The principal molecular constants of the ground state ($^1\Sigma_g^+$) and of the upper state ($^1\Pi_u$) are as follows:

$$B_0'' = 0{\cdot}05611 \qquad r_e'' = 3{\cdot}91 \times 10^{-8} \qquad \alpha'' = 0{\cdot}000219$$
$$B_0' = 0{\cdot}04812 \qquad r_e' = 4{\cdot}22 \times 10^{-8} \qquad \alpha' = 0{\cdot}000235$$

The magnitude of the Λ-type doublings of the $^1\Pi$ state agrees with van Vleck's formula. The relationships between the molecular constants show that all rotational levels, with both even and odd values of J, are present. Alternating intensities are observed, the lines with odd J″ being stronger. It is concluded that the nuclear spin of K^{39} is definitely not zero, and that the nucleus obeys the Fermi–Dirac statistics. AUTHOR.

1626. Wave-Length Standards in the Spectra of Aluminium, Silicon and Bismuth in the Schumann Region. R. V. Zumstein. *Phys. Rev.* 38. *pp.* 2214–2216, *Dec.* 15, 1931.—The second-order spectra of these elements have been photographed along with first-order Fe lines with a 2 m. vacuum grating. Between 1900 and 1500 Å. values are found for the Al lines which check very closely the work of Bowen and Ingram. The Si wave-lengths are 1816·922, 1808·01, 1533·42 and 1526·71. For Bi the values are 1902·33, 1823·71, 1791·82, 1787·39 and 1777·01. These values are believed to be accurate to within about 0·02 Å. AUTHOR.

1627. Spectra in the Vanadium I Iso-Electronic Sequence. Helen T. Gilroy. *Phys. Rev.* 38. *pp.* 2217–2233, *Dec.* 15, 1931.—Regular displacements of multiplets in the iso-electronic sequence which begins with the arc spectrum of vanadium were observed for analogous quartets and sextets in the spectra of MnIII, FeIV, CoV and NiVI, continuing those already known for V I and CrII. In addition a new sextet sequence has been found for V I to CoV. The configuration changes investigated were $3d^44p$ to $3d^44s$, $3d^44d$ to $3d^44p$, $3d^44p$ to $3d^5$ and $3d^34sp$ to $3d^34s^2$. The irregular doublet law was applied to systems of sextets and quartets due to electronic changes in atoms having five electrons in outer shells. When the change did not involve a change in total quantum number, the law was closely followed. Shifts of energy levels for sextets and quartets of (P°D°F°) $3d^44p$ have been calculated for V I to CoV, using the centroid method. Values are not absolute because all the levels of this configuration are not known. But relative values are useful for predicting higher states in the sequence. Typical tests of the Landé interval rule are given. In the regular doublet law $(\Delta\nu)^{1/4}$ is linear with atomic number in some cases, but not in all. Tables are given for the new lines and new term values. AUTHOR.

1628. Hyperfine Structure of Spectrum Lines of Lead Arc in the Visible and the Ultra-Violet Regions. W. Mohammad and P. N. Sharma. *Phil. Mag.* 12. *pp.* 1106–1110, *Dec.*, 1931.—The lines emitted by a vacuum lead arc are investigated for hyperfine structure by means of quartz Lummer-Gehrcke plates. Only the lines 4058, 3640 and 2833 Å. having the 2*s* level in common are found to possess hyperfine structure. It is concluded that the 2*s* level is a triplet with term separations of 0·194 cm.$^{-1}$ and 0·262 cm.$^{-1}$. J. E. K.

1629. Paschen-Back Effect of Hyperfine Structure. Part I. Tl II and Tl III. Part II. Bi II and Bi III. J. B. Green and J. Wulff. *Phys. Rev.* 38. *pp.* 2176–2192, *Dec.* 15, 1931.—The Zeeman effect of several characteristic lines of Tl II and Tl III has been studied at field strengths of 14,700, 32,500 and 43,350 gauss. The transition from weak to strong fields shows exceedingly good agreement with the theory of Goudsmit and Bacher. Careful measurements of the magnetic patterns of certain lines indicate that McLennan and Allin's results are inaccurate. In Part II Goudsmit and Bacher's theory is successfully applied to the spectra of Bi II and Bi III. The lines 5719 Å. of Bi II and 4561 and 3695 Å. of Bi III are used as typical examples of these spectra. 5719, like 3092 Å. of Tl II, serves as an excellent check on the theory, because of its especially simple transition. AUTHORS.

1630. Normal Vibrations of Carbonate and Nitrate Ions. A. C. Menzies. *Roy. Soc., Proc.* 134. *pp.* 265–277, *Nov.* 3, 1931.—The frequencies of the normal modes of vibration are calculated for an equilateral triangle structure consisting of three oxygen atoms, one at each corner of the triangle, and a fourth atom (*e.g.*, C or N) at the centre. Dennison's method is employed, and two of the four equations obtained are not in agreement with Nielsen's calculation [see Abstract 1198 (1929)]. The connections of the present calculation are confirmed by transforming the equations obtained by Kornfeld, when agreement is obtained. Also the precise modes of vibration are found to be analogous to modes occurring in the two most similar structures (those of O_3 and SO_2). Infra-red and Raman data are used to calculate the constants in the formulæ for the cases of calcite and sodium nitrate. High frequencies in the Raman spectra of each salt are identified as $2\nu_1$, while ν_1 itself does not occur in the Raman spectra as a fundamental. A. C. M.

1631. Molecular Scattering of Light. C. V. Raman. *Indian Journ. Phys.* 6. *pp.* 263–273, *Oct.* 13, 1931. *Nobel Lecture.*—An account of the investigations which led up to the discovery of the Raman effect. A. C. M.

1632. Raman Effect in Aldehydes. S. S. Lu. *Tsing Hua Univ. Sci. Reports, Series A.* 1. *pp.* 25–32, *April* 15, 1931.—Benzaldehyde, heptaldehyde and furfurol were investigated, using the Wood method. A. C. M.

1633. Raman Spectra of Organic Substances. Cis- and Trans-Isomers. A. Dadieu, A. Pongratz and K. W. F. Kohlrausch. *Akad. Wiss. Wien, Ber.* 140. 2*a*. 8. *pp.* 647–662, 1931.—The following substances are investigated in order to obtain data for a study of cis- and trans-isomerism: cis- and trans-dibromethylene, stilbene and *iso*-stilbene, diphenylmethane, diphenylethane and tolane. (The last three were investigated in order to get information about the phenyl group as it entered into the stilbene.) The cis-spectra have more lines, and differ markedly from the trans-spectra. [See Abstract 871 (1932).] A. C. M.

1634. Raman Spectra of Inorganic Chlorides. S. Venkateswaran. *Indian Journ. Phys.* 6. *pp.* 275–285, *Oct.* 31, 1931.—The Raman spectra are reported for thionyl chloride, sulphur monochloride, phosphorus trichloride, phosphorus oxychloride and boron trichloride. The frequencies observed are related to the structures of the molecules. S_2Cl_2 is regarded as Cl–S–S–Cl. Boron trichloride has a spectrum similar to that of other trichlorides, but with reversed relative intensities. A. C. M.

1635. Raman Spectrum of Formic Acid. S. Parthasarathy. *Indian Journ. Phys.* 6. *pp.* 287–293, *Oct.* 31, 1931.—Nine lines are observed, all broad. Changes are observed in some of the lines when the acid is heated, and when water is added. The line of lowest shift is found to have a depolarising factor greater than 1. The anomalous behaviour of this line is connected with molecular association in the liquid. A. C. M.

1636. Raman Effect in Gases. S. Bhagavantam. *Indian Journ. Phys.* 6. *pp.* 319–344, *Oct.* 31. 1931.—The Raman effect is measured in H_2, O_2, N_2, CO_2, N_2O, C_2H_2, H_2S, and SO_2 at pressures up to 50 atmospheres, using a special pressure-resisting transparent silica tube. A careful elimination of parasitic light allows an estimation to be made of the absolute intensities and polarisations. Lines due to vibrational transitions are well polarised, while those due to rotational ones are imperfectly polarised. Above a certain pressure, different for different gases, the rotational fine-structure gives place to broad unresolved bands. This pressure corresponds to the stage where the frequency of collision is equal to the frequency of molecular rotation in the one-quantum state. The significance of the results of experiments undertaken prior to 1928 with non-homogeneous light, in which the depolarisation of the scattered light is investigated, is discussed, and it is shown that the formula connecting these old observations with the optical anisotropy of the molecules remains in general valid. The true depolarisation of the Rayleigh scattering for diatomic molecules when spectroscopically studied should be about $\frac{1}{4}$ of the depolarisation of unresolved scattering. [See following Abstract.] A. C. M.

1637. Reversal of Circular Polarisation in Raman Scattering. S. Bhagavantam. *Indian Journ. Phys.* 6. *pp.* 389–400, *Nov.* 30, 1931.—A classical theory of the scattering of circularly-polarised light by rotating molecules is worked out. In the forward direction a part of the total Rayleigh scattering proportional to $(2\mu^2 - \frac{5}{90}\gamma^2)$, is circularly polarised in the same sense as the incident light and a part proportional to $\frac{2}{15}\gamma^2$ is unpolarised. In the rotational Raman scattering in each branch, a part given by $\frac{1}{12}\gamma^2$ is circularly polarised in a *reverse* sense and the other part given by $\frac{1}{30}\gamma^2$ is unpolarised. In the transverse direction the results are identical with those obtained when unpolarised incident light is used. The case of strongly depolarised vibration lines which show the phenomenon of reverse circular polarisation in the forward scattering is briefly discussed. The conclusions are supported by the recent experiments of Bär and Hanle. [See also preceding Abstract.] AUTHOR.

1638. Circular Polarisation of Raman Lines. Part I. W. Hanle. *Ann. d. Physik,* 11. 7. *pp.* 885–904, *Nov.* 23, 1931.—Circular polarisation of the Raman-lines is investigated for CCl_4, $CHCl_3$, benzene, toluene, xylene, monochlorbenzene, benzaldehyde, methyl-, ethyl-, and amyl-alcohols, formic acid, acetic acid, acetone, ether, glycerin, trichlorethane, acetylene tetrachloride, cyclohexane, water, sulphuric acid, nitric acid, ammonia and carbon disulphide. End-on illumination is used, and the backward scattered light is brought into the spectrograph. The light was circularly polarised with a nicol prism and $\lambda/4$ plate. The scattered light was focussed on to the slit of the spectrograph through a calcite crystal, a depolarising crystal slice being used to eliminate discrimination by the spectrograph in favour of one direction of vibration. The unmodified lines are circularly polarised in the original direction, while the accompanying rotation lines are oppositely polarised. The polarisations for the modified (Raman) lines are too detailed to abstract; it can be said that corresponding lines in the different substances have the same type of circular polarisation. A. C. M.

1639. Raman Effect of the Carbon-Halogen Bond. W. D. Harkins and H. E. Bowers. *Phys. Rev.* 38. *pp.* 1845–1857, *Nov.* 15, 1931.—Nine organic aliphatic bromides are investigated using a large three-prism spectrograph. It is concluded from a comparison of the C-Br. line in these compounds that the force constant either remains constant or else it increases only slightly with an increase in length and mass of the normal hydrocarbon chain, and that only a part of the radical R vibrates with respect to the halogen atom in the process in which the characteristic frequency is emitted. A. C. M.

1640. Raman Effect and Nature of Allenic Linkages. M. Bourguel and L. Piaux. *Comptes Rendus,* 193. *pp.* 1333–1335, *Dec.* 21, 1931. The Raman spectrum of allene gives no indication of lines or bands characteristic of either ethylenic or acetylenic linkages [see Abstract 3836 (1931)]. It consists of strong lines at 1074 and 3000, and indistinct bands at 1440 and 3073. Propyl-, butyl-, and dimethyl-allenes give similar results, the changes accompanying substitution being similar to those in the case of the cyclopropanes [see Abstract 1254 (1932)]. It is therefore concluded that the linkages in allene cannot be ethylenic. C. A. S.

1641. Use of X-Rays in Quantitative Analysis. V. Caglioti and P. Agostini. *Accad. Lincei, Atti,* 14. *pp.* 301–305, *Oct.,* 1931.—Of the two X-ray methods employed in quantitative analysis, that involving the use of emission spectra presents various difficulties and occupies much time. More simple and of more general application is the method of Glocker and Frohnmayer [see Abstract 1418 (1925)], based on the intensity of the absorption spectrum. In the case of zinc, which gives a K absorption band lying between the L_{β_3} and L_{β_4} wave-lengths of tungsten, it is found that, when a 1-mm. layer of alumina containing 2 % of zinc oxide is traversed by X-rays, the ratio of the intensities of the two lines is reduced from the normal value 3 : 2 to 1 : 1. With nickel, the K absorption band lies between the K_α and K_β lines of copper. Preparations of alumina containing 0·21, 0·91, 1·97 and 3·98 % respectively of NiO were examined. For these the ratios between the intensities of the K_α and

K_β lines were found to be 5 : 3·9, 5 : 4, 5 : 4·1 and 5 : 4·1 respectively, that is, virtually identical. Marked differences are, however, observed between the ratios of the intensities of the lines λ_a and λ_β in the absorption spectra for these four mixtures, in relation to the comparison spectrum, the absorption of the radiation and the proportionality of the percentage of NiO. T. H. P.

1642. Multiple Structure in X-Ray K-Absorption Spectra. M. Sawada. *Kyoto Coll. Sci., Mem.* 14. *pp.* 229–250, *Sept.,* 1931.—An extended multiple structure of the K-absorption spectra of pure Cr, Mn, Co, Fe, Ni and Cu has been photographed. Some of these extend over an energy range of more than 400 volts. The spectrograms and their micrometer curves are shown. Two hypotheses to account for the multiple structure have been taken into account. The first of these was that of multiple electron transitions due to the absorption of a quantum of X-rays; the second was that of the ejection of a K-electron from the multiply-ionised atom in various shells. These hypotheses are discussed. On the whole the most probable explanation seems to be that both these causes concur in the process of absorption of X-rays. A. D.

1643. Quadruplet Rays in the X-Ray Spectrum. E. Segrè. *Accad. Lincei, Atti,* 14, *pp.* 501-505, *Dec.* 6, 1931.—It has been long known that both in optical and in X-ray spectra there are rays which arise from combinations forbidden by the ordinary rules of selection. The author shows that all the forbidden rays in X-ray spectra are to be accounted for as quadruplet radiations which, in the case of X-rays, are much stronger than in the case of optical spectra. A. D.

1644. Angular Intensity Distribution of Continuous X-Ray Spectrum. Part IV. Stellar Opacity Coefficient. Y. Sugiura. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 339, *pp.* 89–110, *Dec.,* 1931.—Integration of the intensity expression obtained all over the surface of a sphere with radius R_0 enabled the present results to be compared with those from Kramers' theory. The first approximate correcting factor to Kramers' formula for the continuous X-rays was obtained. With a mean value of this correcting factor, the opacity coefficient was estimated to be fairly close to the astronomical value. AUTHOR.

1645. Resolution of the K-β_1 and K-β_3 Lines of the Heavy Metals. H. Seemann.—*Zeits. f. Physik,* 73. 1–3. *pp.* 87–106, *Nov.* 27, 1931.—Several investigators have failed to resolve the K-β_1 and K-β_3 lines in the X-ray spectra of the metals between tantalum and uranium in the table of elements. The want of success is partly ascribable to the use of Bragg's method and partly to the faulty construction of spectrographs. The author's pinhole camera method easily resolves these lines and measures their wave-lengths in the third-order spectra [see Abstracts 1369 (1926) and 2846 (1930)]. Photographs of the resolved lines and also of photometer curves of the photographs for tungsten are shown. Details of the author's method and spectrograph are given. Reasons for the failure of Bragg's method, as used by Siegbahn, de Broglie and others, are discussed. N. D.

1646. New Self-Contained X-Ray Apparatus for Crystal Analysis. R. A. Stephen. *Journ. Sci. Instruments,* 8. *pp.* 385–387, *Dec.,* 1931.—The apparatus consists of an X-ray tube, transformer and cooling fan, camera holders and two Debye-Scherrer cameras. When filled with water the transformer casing functions as a cooling jacket. Two X-ray tubes are provided, with copper and molybdenum anodes and nickel and zirconium filters respectively. There are two apertures to each tube. The tube is mounted on top of the transformer, and when placed in position automatically adjusts the current and voltage to the most favourable values (different, of course, for each tube). When the tube is removed the primary circuit of the transformer is interrupted. Each tube is encased in an earthed metallic covering and has a line focus (6 mm. by 2 mm.). The apparatus can be connected direct to 220-volt a.c. mains. The consumption is 450 watts, the current being 2·8 amperes. All external parts can be handled with safety. The total weight is 54 lb.

J. T.

1647. Diffuse Scattering of X-Rays from Sylvine at Low Temperature. G. E. M. Jauncey and G. G. Harvey. *Phys. Rev.* 38. *pp.* 1925–1931, *Dec.* 1, 1931.—By use of a modification of the photographic method described by Claus the authors have compared the intensities of X-rays of wave-length 0·43 Å. diffusely scattered from sylvine at angles in the range 25° to 90° at a temperature of 90° K., with the intensities at these same angles at a temperature of 300° K. Jauncey and Harvey have shown that the intensity of the diffusely scattered rays should be given by $S = S' - F^2/Z$, where S' is independent of the temperature and F is the atomic structure factor containing the effect of thermal agitation. With James and Brindley's F values at 90° K. and 300° K. theoretical values of S for 90° K. have been calculated. The experimental S values at 90° K. are lower than the theoretical. This result is in accord with that found by Claus for rock-salt. Plotting $\log (S' - S_1)/(S' - S_2)$, where the subscripts refer to the two temperatures, against $(\sin^2\phi/2)/\lambda^2$ a straight line is obtained whose slope agrees with that required by the Waller and not the Debye formula for the temperature effect. It is impossible by means of this experiment to show whether or not there is zero-point energy. In order to do this an assumption concerning the electron distribution in the atom must be made. AUTHORS.

1648. Ionisation Method in X-Ray Measurements. W. Stockmeyer. *Ann. d. Physik,* 12. 1. *pp.* 71–106, *Dec.* 22, 1931.—By means of an ionisation spectrometer, absorption and ionisation measurements have been made on air, sulphur dioxide and ethyl bromide. The absorption coefficients of sulphur dioxide and ethyl bromide were measured over a wave-length range of 0·5 Å. to 2·0 Å. The results may be expressed by a formula of the type $T/\rho = c\lambda^n$, where $n = 3{\cdot}0$ for air, 2·93 for sulphur dioxide and 2·76 for ethyl bromide. The K (absorption change) at the limit for Br is found to be 7·27. The ionisation produced by FeK_α and CuK_α in ethyl bromide and sulphur dioxide relative to air was measured, and it is found that the energy per pair of ions is 24·4 electron-volts for ethyl bromide and 29·7 electron-volts for sulphur dioxide. The ratio of the ionisation in ethyl bromide to sulphur dioxide varies linearly with wave-length for radiations shorter than the K limit of Br. It is deduced that the fractional output of BrK radiation is independent of the wave-length of the absorbed energy. Actually $U_{kBr} = 0{\cdot}56$. It is found from the shape of the saturation curves for ethyl bromide and sulphur dioxide that the ionisation is limited by columnar ionisation as for α-rays. W. V. M.

RADIOACTIVITY.

1649. Radioactivity of Natural Waters and Flowing Artesian Wells. J. A. Hootman. *Am. J. Sci.* **22.** *pp.* **453–463,** *Nov.*, **1931.**—The method used, a modification of Schmidt's "shaking method," is fully described, and an experimental growth curve of the activity of the emanation and its products prepared, diminishing greatly the time required for an observation. Results for 16 flowing wells of depths 60–1800 ft. in the Eutaw and Tuscaloosa formations of the Upper Cretaceous of N.E. Mississippi show radium content varying from 0–0·688 millicurie per litre. [See Abstracts 186 (1913) and 1539 (1915).] C. A. S.

1650. Chart of Radioactive Elements, Indicating their Structure. I. W. D. Hackh. *Science,* **74.** *pp.* **490–492,** *Nov.* **13, 1931.**—The terminology, and some of the data, of the chart are based on the recent report of the International Radium Standards Commission. It is of a very comprehensive nature, showing graphically, in a simple manner, the relations between the different disintegration series. It is possible to read off for each element the proton number or isotopic weight, the number of nuclear electrons, the number of α-particles capable of emission radioactively from the nucleus, before it ceases to be radioactive, the atomic number, the number of normal valence electrons, and the arrangement of the extra-nuclear electrons in the different shells from K to Q.

H. N. A.

1651. Relation between Uranium and Radium. Part IX. The Period of Ionium. F. Soddy. *Phil. Mag.* **12.** *pp.* **939–945,** *Nov.*, **1931.**—Records further measurements of the continued growth of radium according to the square of the time from the uranium preparation purified in 1905–1909. They give for the period of average life of ionium $\Theta_2 = 1{\cdot}06 \times 10^5$ years, when the period of average life of radium Θ_3 is taken as 2300 years. This value of Θ_2 gives $T_2 = 73{,}500$ years and $\lambda_2 = 3{\cdot}0 \times 10^{-13}\,(\text{sec})^{-1}$. It is unlikely that further continuations of these measurements will lead to a more accurate determination of Θ_2. It appears to be more accurate than the somewhat higher values of Stefan Meyer and (Mmes.) Curie and Costelle, using a thorium ionium preparation for which the proportion of ionium has been deduced from atomic weight determinations. [For Part VIII see Abstract 2116 (1924).] H. N. A.

1652. Range of α-Particles from Uranium II. S. Bateson. *Canad. J. of Research,* **5.** *pp.* **567–571,** *Nov.*, **1931.**—The range of the α-particles from uranium II has been determined by a scintillation method to be 3·29 ± 0·08 cm. at 15° C. and 760 mm. This is in good agreement with Laurence's value found with a Wilson chamber. From the Geiger-Nuttall relationship the period is calculated to be 28,000 years, a value considerably less than that found recently by direct measurement. AUTHOR.

1653. Interaction Energy of Two α-Particles at Close Distances Determined from the Anomalous Scattering in Helium. H. M. Taylor. *Roy. Soc., Proc.* **134.** *pp.* **103–125,** *Nov.* **3, 1931.**—Uses a modified form of Gamow field about the nucleus, similar to that employed by Sexl in calculating the decay periods of radioactive substances. Sexl assumed that the depth of the "hole" of negative potential around the centre of the nucleus was zero in the case of heavy elements, but for light elements such as helium the author finds that the depth is quite large. Calculations are made assuming a cylindrical hole of uniform depth, and also with a conical hole, the depth increasing from the crest of the potential "hill" towards the centre of the nucleus. The former gives numerical results which agree better with the experimental values for the scattering than the second. It is shown that the form of the peak of the hill can be modified considerably, without appreciably altering the numerical results. The pointed crest can be cut away, and the curve made to approximate at the crest to that of Gamow. It is shown that the distance between the centres at which the interaction energy ceases to be that given by Coulomb's law is about $3 \cdot 5 \times 10^{-13}$ cm. When the field as determined is applied to the calculation of the energy of binding of two α-particles to form a stable nucleus of mass number 8 the results are not in good agreement with what is to be expected. The methods of wave mechanics are employed throughout the paper. H. N. A.

1654. β-Particles from Radium D. H. O. W. Richardson. *Roy. Soc. Proc.*, 133. *pp.* 367–380, *Oct.* 1, 1931.—Using a Wilson expansion chamber and three different gas mixtures, 377 tracks of β-particles of energies > 6000 volts, from a radium D source on gold leaf of mass $0 \cdot 19$ mg./cm^2, photographed stereoscopically, were measured. The corrected number/energy curve shows maxima at 41,000 volts, ascribed to unresolved secondary groups from the M and N levels, at 29,000 volts (much higher), from the L levels (chiefly L_1), and at 18,000 volts, probably only a large probability fluctuation in a continuous distribution; a minimum at 13,000 volts, and then a rise to 6000 volts accountable for by tertiary electrons. The numbers per disintegration are for secondary particles of L origin $0 \cdot 38$, of M and N origin $0 \cdot 29$, for tertiary particles $0 \cdot 19$, and for nuclear particles $0 \cdot 86$. [See Abstract 3087 (1929).] C. A. S.

1655. Calorimetric Study of the Absorption of γ-Rays of Radium. D. K. Yovanovitch and P. Savitch. *Comptes Rendus*, 193. *pp.* 1006–1008, *Nov.* 23, 1931.—The micro-calorimetric method previously described [see Abstract 1433 (1927)] has been applied to the study of the variation of the heat evolved on absorption of γ-radiation by various thickness of lead, silver and copper. With lead the curve obtained approximates to the equation $q = q_0(1 - e^{-(\mu m)/(\rho s)})$, but with silver and copper the absorption is much more complex. It is probable that in the lighter metals the whole of the electrons produced by the radiation are not absorbed at the same depth, but are in part emitted from the metal. H. F. G.

1656. Penetrating Radiation of Polonium. Marietta Blau and Elisabeth Kara-Michailova. *Akad. Wiss. Wien, Ber.* 140. 2*a*. 8. *pp.* 615–622, 1931.—The existence of the penetrating radiation of polonium was established and the diminution coefficient on absorption by lead was measured both by the ionisation method and also by means of the electron counting tube. The absorption curves are traced up to $4 \cdot 5$ cm. of lead and are compared with absorption measurements made under the same conditions on RaB + C and ThB + C. J. J. S.

1657. Significance of the Compton Effect in Absolute γ-Ray Absorption Measurements. L. H. Clark. *Phil. Mag.* 12. *pp.* 913–938, *Nov.*, 1931.—As the result of a series of experiments, in some of which the electroscope and ionisation chamber employed was enclosed on all sides by a lead case 1 cm. in thickness, while in others the protection from scattered γ-rays was less, the author comes to the following conclusions. After the γ-rays of radium have traversed approximately 2 cm. of lead they constitute a homogenous beam of radiation, the value of μ remaining practically constant at $0 \cdot 50$ cm.$^{-1}$. Some of the scattered rays have a penetrating power approaching that of the primary rays, while others are practically all absorbed by 1 cm. of lead. If the lead walls are only $0 \cdot 16$ cm. thick the value of the absorption coefficient of the radiation transmitted by 15 cm. of lead appears to vary from $0 \cdot 75$ cm.$^{-1}$ to $0 \cdot 25$ cm.$^{-1}$. In comparison with the scattered radiation which then enters the ionisation chamber the effect of scattered radiation which is able to enter an electroscope having walls 1 cm. thick is slight. These penetrating scattered rays enter the electroscope through the side facing the source of radiation, and are due to forward scattering. The effect of aluminium as a lining for the electroscope has been studied.

H. N. A.

1658. Nuclear γ-Radiation Excited in Beryllium and Lithium by α-Rays of Polonium. Irène Curie. *Comptes Rendus*, 193. *pp.* 1412–1414, *Dec.* 28, 1931.—The α-particles from a source of polonium of some 100 millicuries, acting on beryllium, produce γ-radiation about five times as intense as that from polonium itself, but with a coefficient of mass absorption, $(\mu/\rho)_{\text{Pb}}$ $0 \cdot 013$, wave-length $0 \cdot 6$–$0 \cdot 7$ X, and energy 15–20 × 10^6 electron-volts. Under similar conditions lithium gives γ-radiation of intensity about equal to that of polonium, $(\mu/\rho)_{\text{Pb}}$ $0 \cdot 15$, λ 20 X, and energy 6×10^5 electron-volts. The results do not appear to favour the theory that this radiation is due to capture of an α-particle by the nucleus of the light element. [See Abstract 1583 (1931).] C. A. S.

1659. Excitation of Nuclear γ-Rays in Boron by α-Particles: Quantum Energy of the γ-Radiation of Polonium. F. Joliot. *Comptes Rendus*, 193. *pp.* 1415–1417, *Dec.* 28, 1931.—Under similar conditions [see preceding Abstract] boron emits γ-radiation of $(\mu/\rho)_{\text{Pb}}$ $0 \cdot 02$, (that of polonium itself being $0 \cdot 083$), and energy 11×10^6 electron-volts. This result is deemed to support the theory of capture of an α-particle by the boron nucleus. C. A. S.

HEAT.

1660. Thermal Conductivities of Metals and Alloys. L. C. Bailey. *Roy. Soc., Proc.* 134. *pp.* 57–76, *Nov.* 3, 1931.—Continues the work of C. H. Lees [see Abstract 1677 (1908)] on the effect of temperature on the thermal conductivities of certain metals and alloys. The author has used the same rods as were used by Lees. The range of temperature is from 60° C. to a maximum of 550° C., the limits of Lees' experiments having been −160° to 15° C. A guard-tube method is employed in the present experiments, and results are given for aluminium, which shows a maximum (0·540) at 225° C.; silver, with a minimum (0·838) at 400° C.; zinc, with a continuous decrease to 0·238; cadmium, which shows a discontinuity near 50° C.; and brass and platinoid, whose conductivities increase rapidly with temperature. Tables and curves are given, and these show that the generally accepted rule for pure metals, that conductivity decreases with increase of temperature, does not hold in all cases. T. B.

1661. Problem in Heat Conduction. C. E. Wright. *Phil. Mag.* 12. *pp.* 1015–1019, *Nov.*, 1931.—The effect of a steady source of heat at one end of an infinite bar, whose other end is kept at zero temperature, has not received any complete discussion, and a treatment of the problem is now submitted which is based on Kelvin's formula for an instantaneous source of heat. H. H. Ho.

1662. Heat Flow through Granulated Material. J. H. Awbery. *Phil. Mag.* 12. *pp.* 1152–1155, *Dec.*, 1931.—Discusses theoretically the heat flow through a material composed of layers of similar and similarly situated conducting bodies. It is shown that the heat flow is independent of the size of the individual bodies, and depends only on the type of packing and the conductivity of the material composing them. J. H. A.

1663. Heat Transmission Rates Round a Tube in a Transverse Current of Fluid. J. Small. *Engineering,* 132. *pp.* 569–570, *Nov.* 6, 1931.—A cylinder of wood, 8 cm. in diameter, is placed transversely in a wind-tunnel of about 2 ft. square section, and air at different speeds is blown through the tunnel. The middle section of the cylinder is fitted with an electric heater, and along a generating line of this section is a linear thermopile of copper-constantan, which is kept at a temperature of 56° F. above that of the air. The relative rates of heat transmission from the hot surface of the cylinder at various angles to the direction of the air stream are then given by the measured e.m.f.s of the thermopile when placed in different relative positions by gradual rotation of the cylinder round its axis. It is found that maximum heat loss is obtained at between 40° and 50° of angle, and minimum loss at 90° from the front. There is another maximum, but not so high as the first, at 180° (at the downstream position). The minimum rate of heat transmission is only about 0·3 to 0·4 of the maximum, this figure becoming greater with increase of wind speed. T. B.

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1664. Maximum Value of the Heat-Transmission Coefficient from a Plane Lamina to a Fluid in Motion. L. Crocco. *Accad. Lincei, Atti,* 14. *pp.* 490–496, *Dec.* 6, 1931.—A mathematical paper dealing with the effect of viscosity in the heat transfer problem involved when a liquid flows past a heated plane lamina. As the velocity of flow is increased, the heat developed in overcoming viscous forces increases, and in fact the temperature of the fluid would ultimately rise to such a point that the heat flow is from the liquid to the lamina. Thus there is below this point a velocity for which the transfer is maximum. The calculation shows that this occurs where $T = 2\,\theta_p/7$, T being the rise of temperature which would follow if the fluid were adiabatically brought to rest, and θ_p the excess of the surface temperature of the lamina over that of the fluid. A general theorem is also proved: the heat transfer between any body whatever, and a fluid in motion with respect to it, is governed by the same laws as apply in the absence of viscosity, provided that the temperature of the fluid is replaced by the temperature it would have if adiabatically brought to rest. J. H. A.

1665. High-Temperature Research Equipment. R. B. Sosman. *Indust. and Engin. Chem.* 23. *pp.* 1369–1374, *Dec.* 1, 1931.—A comprehensive survey of present-day American conditions, calling attention to recently developed apparatus such as an electric resistance furnace in which the air is artificially circulated by a fan made of heat-resisting metal, and the recent applications of solar energy as a source of high-temperature heat. Temperature measurement is also briefly reviewed, but the original paper should be consulted for details. J. H. A.

1666. Constant Temperature Laboratory. H. Abraham. *Comptes Rendus,* 193. *pp.* 1402–1404, *Dec.* 28, 1931.—Describes an attempt to keep the temperature of a cellar room constant, at about 6° C. above the natural winter temperature of the cellar. It was found necessary to mix the air constantly, as otherwise the upper part of the room was 1·5° C. warmer than the lower part. The difference could be kept down to 0·05° C. A metal thermostat containing toluene was employed; the expansion of the liquid deforms a flexible metallic membrane, which works the contact of the heating circuit. The arrangements which prevent excessive variations of the temperature, owing to the breaks and the variations in the heating current, are described. It was found possible to keep the mean diurnal temperature constant, to within 0·001° C., for nearly three months. There are, however, accidental perturbations, which amount to 0·01° C. in a few minutes. These seem to be due to variation in the atmospheric pressure; they do not greatly affect apparatus enclosed in air-tight boxes. H. N. A.

1667. High-Temperature Control: Photoelectric Pyrometry. L. R. Koller. *Indust. and Engin. Chem.* 23. *pp.* 1379–1381, *Dec.*, 1931.—Light from the hot body falls on a photoelectric cell, causing a current to flow which varies with the temperature of the hot body. This current can be amplified and so used to operate suitable control devices. In the device described, a thyratron is employed in the control device, thus eliminating the need for an extremely complicated relay. J. H. A.

1668. Thermal Expansion of Heat-Resisting Alloys: Nickel-Chromium, Iron-Chromium and Nickel-Chromium-Iron Alloys. P. Hidnert. *Bureau of Standards, J. of Research,* 7. *pp.* 1031–1066, *Dec.*, 1931.—This paper gives data on the linear thermal expansion of various heat-resisting alloys (nickel-chromium, iron-chromium and nickel-chromium-iron alloys). The alloys contain 0 to 77 % Ni, 5 to 27 % Cr and 0 to 82 % Fe. The coefficients of expansion of the alloys were determined for various temperature ranges between 20° and 1000° C., and the effects due to temperature, chemical composition, heat treatment, etc., were determined. Critical regions were located on the thermal expansion curves of some of the alloys. For a given temperature range, the coefficients of expansion of Ni-Cr alloys containing from 0 to about 20 % Cr are nearly the same. The effects of chromium content, carbon content, heat treatment, etc., on the coefficients of expansion of Fe-Cr alloys for various temperature ranges are indicated in a figure. The results on the thermal expansion of Ni-Cr-Fe alloys were correlated with the structure of the alloys. Transformations from one phase to another caused significant changes in thermal expansion. The expansion curves on the first heating of nearly all of the cast Ni-Cr-Fe alloys indicate a retardation or decrease in expansion between 700° and 800° C., due to precipitation of carbide. The effects of change of composition on the coefficients of expansion of both cast and annealed Ni-Cr-Fe alloys are indicated. The table in the summary gives a comparison of the coefficients of expansion of the three groups of alloys. AUTHOR.

1669. Flame Temperatures. W. T. David, W. Davies and J. Jordan. *Phil. Mag.* 12. *pp.* 1043–1057, *Nov.*, 1931.—Measurements of flame temperatures developed during the explosive combination of gaseous mixtures in closed vessels and measured by fine platinum-rhodium resistance wires lead to the conclusion that flame temperatures so measured or determined by the method of spectral reversal are not generally, or necessarily, temperatures corresponding with the mean translational energy of the molecules in the flame. J. S. G. T.

1670. Boiling Points and Vapour Pressures of Normal and Para-Hydrogen. W. H. Keesom, A. Bijl and (Miss) H. van der Horst. *K. Akad. Amsterdam, Proc.* 34. 9. *pp.* 1223–1230, 1931. *Comm. No.* 217*a from the Phys. Lab., Leiden.*—Normal hydrogen is that mixture of ortho- and para-hydrogen which is in equilibrium at room-temperature. Its boiling point was found to be at − 252·754° C., in good agreement with six other determinations carried out at different times by various observers. It changes about 0·0008° per hour, due to ortho-hydrogen becoming transformed into the para form, and so may be used as a fixed point in thermometry if the liquid hydrogen is not kept too long. The boiling point of para-hydrogen is at − 252·871° C. Equations for the vapour pressure of both forms are given from − 253° to − 258° C. J. H. A.

1671. Vapour Tension, Critical Point and Triple Point of Carbon Monoxide. C. A. Crommelin, W. J. Bijleveld and E. G. Brown. *K. Akad. Amsterdam, Proc.* 34. 9. *pp.* 1314–1317, 1931. *Comm. No.* 217*b from the Phys. Lab., Leiden.*—The CO was prepared from anhydrous sodium formate and sulphuric acid. The vapour pressure has been measured over the liquid, and also over the solid, the measurements covering in all the range − 140° to − 216° C. (0·01 to 34 atmospheres). The critical point is at 132·88° Absolute, the boiling point at 81·61° and the triple point at 68·10°. The corresponding pressures in atmospheres are 34·529, unity and 0·15146. J. H. A.

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1672. Isotherms of Hydrogen, Carbon Monoxide and their Mixtures. D. T. A. Townend and L. A. Bhatt. *Roy. Soc., Proc.* 134. *pp.* 502–512, *Dec.* 2, 1931.—Previous work in this field [see Scott, Abstract 1116 (1930)] is now extended, the isotherms of hydrogen, carbon monoxide and three mixtures of these gases containing 66·6, 50·2 and 33·3 % of hydrogen respectively having been determined over a pressure range extending to 600 atmospheres at both 0° and 25° C. Each isotherm has been expressed in the form $pv_A = a + bp + cp^2 + dp^3$, and the values of a, b, c and d tabulated in each case. The isotherms of the mixtures, which are similar to those of hydrogen and nitrogen, show that over certain pressure ranges extending from about 300 to 470 atmospheres the mixtures are less compressible than either of the constituent gases.

H. H. Ho.

1673. Physical Properties of Compressed Gases. Part II. Carbon Monoxide. W. E. Deming and Lola E. Shupe. *Phys. Rev.* 38. *pp.* 2245–2264, *Dec.* 15, 1931.—The experimental data on the relations between pressure, volume and temperature for CO are smoothed and adjusted, using the graphical methods developed in Part I of the paper [see Abstract 2735 (1931)]. The results are tabulated from – 70° to 400° C. and up to 1200 atmospheres pressure. The quantities given are specific volume, density, expansion coefficient, isothermal pressure coefficient, fugacity, specific heat at constant volume and constant pressure and the Joule–Thomson coefficient. The qualitative trends of most of the curves are similar to those for nitrogen, in agreement with the similar molecular structure of the two gases. The second virial coefficient has the value $58 \cdot 03 - 19 \cdot 84\,T^{-1}$ in cc./mole for temperatures between – 70° and + 400° C.

J. H. A.

1674. Reciprocal Relations in Irreversible Processes. Part II. L. Onsager. *Phys. Rev.* 38. *pp.* 2265–2279, *Dec.* 15, 1931.—A general reciprocal relation, applicable to transport processes such as the conduction of heat and electricity, and diffusion, is derived from the assumption of microscopic reversibility. In the derivation, certain average products of fluctuations are considered. As a consequence of the general relation $S = k \log W$ between entropy and probability, different (coupled) irreversible processes must be compared in terms of entropy changes. If the displacement from thermodynamic equilibrium is described by a set of variables $\alpha_1 . \ldots, \alpha_n$, and the relations between the rates $\dot{\alpha}_1, \ldots \dot{\alpha}_n$, and the "forces" $\partial S/d\alpha_1, \ldots, \partial S/d\alpha_n$, are linear, there exists a quadratic dissipation-function, $2\Phi(\dot{\alpha}, \dot{\alpha}) \equiv \Sigma \rho_j \dot{\alpha}_{ij} \dot{\alpha}_i = dS/dt = \dot{S}(\alpha, \dot{\alpha}) \equiv \Sigma(\partial S/d\alpha_j)\dot{\alpha}_j$ (denoting definition by $\equiv$). The symmetry conditions demanded by microscopic reversibility are equivalent to the variation-principle $\dot{S}(\alpha, \dot{\alpha}) - \Phi(\dot{\alpha}, \dot{\alpha}) =$ maximum, which determines $\dot{\alpha}_1, \ldots \dot{\alpha}_n$ for prescribed $\alpha_1, \ldots, \alpha_n$. The dissipation-function has a statistical significance similar to that of the entropy. External magnetic fields, and also Coriolis forces, destroy the symmetry in past and future; reciprocal relations involving reversal of the field are formulated. For Part I see Abstract 2364 (1931).

AUTHOR.

SOUND.

1675. Theory of Dispersion of Sound and Dispersion of H.F. Sound-Waves in Carbon Dioxide. H. O. Kneser. *Ann. d. Physik*, 11. 6. *pp.* 761–776, *Nov.* 10; 11. 7. *pp.* 777–801, *Nov.* 23, 1931, and 12. 8. *pp.* 1015–1016, *March* 10, 1932.—When a disturbance takes place in a gas, as during an adiabatic compression, a certain very small interval of time elapses before equilibrium of the external and internal energies is restored. The period of readjustment is determined by the life of the energy quantum, and is accompanied by an increase in the speed of sound. With certain assumptions as to the exchange of quanta of energy during the collisions of molecules, a dispersion equation is derived for the propagation of sound in a gas. It contains one thermodynamically indeterminate term, namely, the life-period of the exciting energy. In the second paper the experimental measurements are described. The method adopted was that of Pierce [see Abstract 341 (1926)] and by the use of quartz oscillators with frequencies from 60,930 to 1,480,000, the speed of sound in CO_2 was measured relatively to that in A. In the frequency range 10^5 to 6×10^5, the speed increases by 3·7 %, and again becomes constant at a frequency of 12×10^5. There is good agreement between theory and experiment, if vibrational energy is taken in place of rotational energy. The life of the vibration quanta is calculated as $(1{\cdot}0 \pm 1{\cdot}2)10^{-5}$ sec. Other gases are being investigated. G. E. A.

1676. Velocity of Longitudinal Vibration in Solid Rods (Ultrasonic Method), with Special Reference to the Elasticity of Ice. R. W. Boyle and D. O. Sproule. *Canad. J. of Research*, 5. *pp.* 601–618, *Dec.*, 1931.—An experimental research showing how corrections in the value of velocity of phase propagation may be made to take into account lateral inertia, and how the law (Rayleigh's) will break down at higher frequencies because of other types of vibration intervening. When the ratio of radius to length, multiplied by the mode of vibration (kr/l) exceeds a certain figure (in the case of duralumin, 0·55) the law breaks down, and it appears that radial longitudinal vibrations intervene. From the research a simple method emerges to determine Poisson's ratio, which in the case of duralumin is found to be 0·35. An application of this ultrasonic method is made to determine Young's modulus for ice, in order to find more consistent values than those generally quoted. The value of this modulus for ice at about 0° C. is found to be about 9×10^{10} dynes/cm.^{2} corresponding to a velocity of sound in it of $3{\cdot}15 \times 10^5$ cm. per sec. AUTHORS.

1677. Velocity of Sound in Cylindrical Rods. G. S. Field. *Canad. J. of Research*, 5. *pp.* 619–624, *Dec.*, 1931.—The experimental knowledge so far available of the velocity of longitudinal waves in cylindrical rods is reviewed, and it is shown that a close analogy most probably exists between waves in cylinders of liquid and in solid rods. The theory for rods due to Pochhammer is considered with reference to a specific case for which experimental velocities have been determined, and it is shown that the agreement at low frequencies is good. At higher frequencies, however, theory and experiment differ widely. AUTHOR.

1678. Circulations Caused by the Vibration of Air in a Tube. E. N. da C. Andrade. *Roy. Soc., Proc.* 134. *pp.* 445–470, *Dec.* 2, 1931.—For audible frequencies, smoke particles follow closely the motion of the air in which they are suspended, and can be used as tracing points. At all frequencies except the lowest, dust particles act as semi-stationary obstacles in the vibrating air. Smoke particles can therefore be used to measure the amplitude and energy of the air vibrations. When the gas in a tube is set in vibration by a diaphragm, it moves from antinode to node along the wall, and returns up the centre, as predicted by Rayleigh, and any particle which does not share the vibratory motion of the air may be the centre of a vortex motion the characteristics of which are described. Expressions are found which determine whether the periodic motion of the air about an obstacle will produce vortex motion or irrotational motion, and it is shown that in all previous experiments on the forces between spheres in vibrating air, the motion, tacitly assumed to be irrotational, was actually vortex motion. [See also Abstract 4256 (1931).] G. E. A.

1679. Minimising Discrepancies of Intonation in Valve Instruments. J. Redfield. *Acoustical Soc. of America, J.* 3. *Part* 1. *pp.* 292–296, *Oct.*, 1931.—Most valve instruments are out of tune to an unnecessary degree. Taking the baritone horn as an example, with three valves for lowering the pitch respectively a semitone, a whole tone and a minor third, on the even-tempered scale, it is shown that if the notes produced by the valves singly are correct, those produced by any combination of the valves must be too sharp. The solution of the difficulty lies in a compromise which equalises the deviations from the even-tempered scale within the tolerance of the ear for pitch acuity, provided that the third valve (the furthest out of tune) is never used alone. Further correction by lipping is within the capabilities of the average player of brass instruments. The application of the method to the different instruments involved is given with additional details. G. E. A.

1680. Sound Spectra of Musical Instruments. E. Meyer. *Zeits. f. techn. Physik,* 12. 12. *pp.* 606–611, 1931.—An automatic apparatus was used in detecting and measuring the partials of all the instruments of the orchestra. The method was based on that of Grützmacher in which a search-tone of variable frequency causes resonance when in unison with a partial, or forms with it a difference tone of the first order. The frequency range of the analysis extended from 30 to 15,000, and the analyses include the start and finish of the sound. It is noted, for example, that if the sound of an electrical piano does not include the initial percussion effects it has an exact resemblance to the sound of a harmonium. Stringed instruments which are struck or plucked give a continuous spectrum, in addition to the spectrum of partials. In all instruments the number of partials diminishes as the pitch rises. In the bowed-string instruments, fundamentals of low pitch are radiated feebly or not at all. Some of the brass-wind instruments are distinguished by giving all the lower partials with the same intensity. Percussion instruments give, as a rule, entirely continuous spectra, but the triangle records an unharmonic line spectrum extending up to 16,000 hertz. On the other hand, an ordinary loudspeaker has a frequency range from 100 to 6000 at the most. G. E. A.

ELECTRICITY AND MAGNETISM.

ELECTROSTATICS, TERRESTRIAL ELECTRICITY AND MAGNETISM.

1681. Plotting Electric Fields in Mixed Dielectrics. J. F. T. Young. *Roy. Soc. Canada, Trans.* 25. *Sect. III. pp.* 185–189, *May,* 1931.—The experiments outlined deal with the electric field of a current distribution and illustrate a normal field between electrodes, the effect of a low dielectric on the field, the effect of a conductor on the field, refraction of a line of electric intensity, and the field between a point and a plate.
H. H. Ho.

1682. Theory of Breakdown of Dielectrics. L. Rosenkewitsch and C. Sinelnikow. *Zeits. f. Physik,* 73. 1–2. *pp.* 118–120, *Nov.* 24, 1931.—The authors suggest a possible primary state in the breakdown of dielectrics at low temperatures. Reference is made to a paper by Oppenheimer [see Abstract 1172 (1928)] in which the quantum theory of aperiodic effects is given.
H. L. B.

1683. Electrical Properties of Stretched Rubber. A. Gemant. *Zeits. f. Physik,* 73. 7–8. *pp.* 526–537, *Dec.* 30, 1931.—The technically important electrical properties of rubber are improved by stretching to about 40 %, but the effect tends to be obscured during long periods of time by the detrimental action of ozone. The improvement on stretching is ascribed to surface condition. Data are given for electric strength, porosity and dielectric loss.
H. H. Ho.

1684. Temperature Coefficient of the Dielectric Constant of Water. R. T. Lattey, O. Gatty and W. G. Davies. *Phil. Mag.* 12. *pp.* 1019–1025, *Nov.,* 1931.—This work employs an experimental method previously described by the authors, and the results now obtained are found to be in good agreement with the formula $\log_{10} D = 1 \cdot 94361 - 0 \cdot 0020045t$, or $\log_e D = \log_e 87 \cdot 824 - 0 \cdot 004515t$. Tables of data for comparative purposes are given, including those of other observers.
H. H. Ho.

1685. Influence of Electrolytes on the Dielectric Constant of Water. Part I. Experimental Method. Part II. Uni-Univalent Salts. R. T. Lattey and W. G. Davies. *Phil. Mag.* 12. *pp.* 1111–1136, *Dec.,* 1931.—The results of measurements on solutions of four uni-univalent salts at 18° and 25° by a voltage-tuning method show that the presence of a salt in water produces, in the dielectric constant, an increase which is proportional to the concentration, and is the same for each uni-univalent salt within the limits of experimental error. The increase at 18° is equal to that at 25° for salts of the same concentration.
T. H. P.

1686. Saturation Current and Processes at the Electrodes in Dielectric Liquids. A. Nikuradse. *Phys. Zeits.* 32. *pp.* 945–948, *Dec.* 1, 1931.—Investigation shows that the carriers of charge in pure liquids chiefly have their seat in the liquid layer close to the metal (surface ionisation). It is to be assumed that the source of ionisation is to be found in the boundary layer metal-liquid. As causes of the production of the charge carriers, (1) photoelectric action at the electrodes, or (2) mutual action of the liquid and metal (contact potential), are assumed. Probably both factors play a part in the process. J. J. S.

1687. Measurement of Dielectric Constant at Radio-Frequencies. H. L. Andrews. *Physics,* 1. *pp.* 366–379, *Dec.,* 1931.—A new method of making dielectric constant measurements on gases at radio-frequencies is described. This method eliminates the difficult condenser calibration required by earlier heterodyne methods. In addition, the effect of certain errors in previous methods can be estimated. The dielectric constant is obtained in terms of a single frequency standard, whose absolute frequency can be determined by auxiliary apparatus described. The method has been used to measure the dielectric constant of nitrogen at room-temperature over a pressure range from zero to seven atmospheres. All measurements were made at a frequency of 884 kilocycles. The final value of $\epsilon - 1$ at N.P.T. = 0·000589 is probably correct in absolute value to better than 0·5 %. AUTHOR.

1688. Dielectric Constant of Commercial Nitrogen at High Pressures. J. W. Broxon. *Phys. Rev.* 38. *pp.* 2049–2050, *Dec.* 1, 1931.—The dielectric constant of commercial nitrogen, 99 % pure, was measured at pressures up to 167 atmospheres by the same electrometric method previously employed by the writer in the determination of K for air [see Abstract 3174 (1931)]. (K − 1) was again found to vary directly with the pressure, at the rate of 556×10^{-6} per atmosphere at 16·5° C., with the exception of an apparent slight deviation from linearity in the sense of a smaller rate of increase of K with P at pressures above 150 atmospheres. The greatest departure from linearity was only of the order of the probable error, however, and is not considered to be definitely established. AUTHOR.

1689. Electrostatic Energy of Dipole Molecules in Different Media. R. P. Bell. *Faraday Soc., Trans.* 27. *pp.* 797–802, *Dec.,* 1931.—Martin [see Abstract 1673 (1930)] has recently employed as a model of a dipole molecule two oppositely charged spheres in contact, but while such a model seems appropriate to the undissociated molecule of a mono-monovalent electrolyte, it is less suited to the general representation of a dipole molecule and does not lend itself to mathematical treatment. The present author now calculates the change of electrostatic energy in transferring an ideal dipole molecule from one medium to another, and shows that only in extreme cases is this energy change the determining factor for the distribution coefficients of dipole molecules. In the case of water and ammonia molecules there is a semi-quantitative agreement with the formula derived. H. H. Ho.

1690. Branching of Lightning. B. F. J. Schonland. *Nature,* 128. *pp.* 794–795, *Nov.* 7, 1931.—In an ordinary spark discharge between spherical electrodes there are always numerous side-branches forking away from the positive pole. Usually in thunderstorms the branching is from the cloud downwards, and so indicates a positively charged cloud-base. To test this conclusion, experiments were made in South Africa on the electric field change near the ground during flashes, and in 95 % of the cases the cloud-base was proved to be negative. However, in thunderstorms, the gap is unsymmetrical, and also space charges in the electric field between the cloud and the ground are caused by projections such as hills, trees and so forth. Branching from a negative electrode has been obtained by representing similar conditions on a smaller scale in the laboratory. H. M. B.

1691. Lightning Flashes of Bead and Thread Form. E. Mathias. *Comptes Rendus,* 193. *pp.* 1140–1143, *Dec.* 7, *and pp.* 1375–1377, *Dec.* 28, 1931.—The flash of bead form is due to a series of consecutive flashes of which the last is the most intense, and on which the nearly extinct detached remains of an earlier flash are superposed. The beads are joined by a thin vein [see Abstract 2765 (1931)]. Observations by Galland, Lely and Planté of this type of flash and of the relative dimensions of bead and vein are given. The other type consists of luminous threads and dark strips, and observations of it by Luizet and Pierre are given. In this case the last flash is the feeblest, the colour being yellow. R. S. R.

1692. Static Thunderstorm Field. F. Ollendorff. *Arch. f. Elektrot.* 25. *pp.* 789–795, *Dec.* 18, 1931.—The electrostatic field of a thundercloud is calculated in an elementary way. A circular limited double layer is calculated, instead of the earlier hypotheses of an unlimited double layer, as system of the charges of the cloud. By means of the equivalence relation between vortex lines and double layer the field is expressed by an electric vector potential calculated in an elementary way. This agrees with the magnetic vector potential of a circular current. The vortex of the electric vector potential determines the electric field, whilst the temporal derivative of this vector potential gives the quasi-stationary magnetic field of the thundercloud current. The field of the induced earth charges is considered by a mirror method, and the electric field at the earth's surface is calculated which is influential as regards danger of lightning stroke. The result is expressed by a set of curves which can be universally applied for all magnitudes. Especially from observations at the earth's surface deductions can be drawn as to some thunderstorm data. A numerical example indicates that the basic hypotheses agree with experiment. J. J. S.

1693. Ionisation of the Atmosphere Measured from Flying Aircraft. D. C. Rose. *Canad. J. of Research,* 5. *pp.* 625–635, *Dec.,* 1931.—The Gerdian type of atmospheric ionisation measuring apparatus was attached to a cabin aeroplane so that the state of ionisation of the atmosphere could be studied. The limitations of the apparatus for aeroplane use are discussed. Measurements were taken from ground level to heights of 15,000 ft. The results are plotted in number of ions per c.c. (separate curves for positive and negative) at different altitudes. The results indicate that at the cloud level there is an abnormal excess of small positive ions and a minimum in the excess of positive ions over negative ions from 4000–6000 ft. higher. This does not include large ions such as charged water drops or dust particles. The observations were taken in regions free from clouds, the cloud level being determined by observation on clouds in the sky, and by relative humidity measurements taken at the same time. AUTHOR.

1694. Mobilities of Atmospheric Large Ions. R. K. Boylan. *Roy. Irish. Acad., Proc.* 40*a*. *pp.* 76–85, *Dec.,* 1931.—Atmospheric air from a well-ventilated room in Dublin is tested by methods due to McClelland and Zeleny, in order to find if any ions of very low mobility are present.

Discontinuities in the curves obtained by the first method indicate the Langevin ion (0·00033) and several groups of ions of mobilities 0·00011, 0·000059 and so forth. The mobilities are verified by the second method. Israël [see Abstract 4294 (1931)] by a new method notes ions of mobilities 0·0002, 0·00011 and $\leq$ 0·00006. These slower ions must play a considerable part in atmospheric electricity, but may not be present in country air. H. M. B.

1695. Barometer Effect in Cosmic Rays. W. Kolhörster and L. Tuwim. *Gerlands Beitr. z. Geophys. Supplementband I. pp.* 87–126, 1931.—The relation of the intensity of cosmic radiation to the variations of the height of the barometer in the course of changes of the weather in the same place is designated the barometer effect. With high barometer the strength of the radiation is in general smaller than with low barometer. As measure of the barometer effect is taken the change of the ionisation in a closed vessel for 1 cm. change in barometric height, the change being measured as a percentage of the total ionisation of the cosmic radiation. This paper is an elaborate review of recent experiments on this subject both on land at different levels and in balloons. It is concluded that an agreement of the variations of the barometer effect over long periods of time is established, so that in consequence from direct measurements of the barometer effect the same values will follow as from other simpler absorption measurements. The variations of the barometer effect with the meteorological conditions which are shown by all more exact measurements are especially to be studied in order that exact corrections for the cosmic radiation may be obtained. J. J. S.

1696. Absorption Coefficients of Cosmic Radiation. W. Kolhörster and L. Tuwim. *Gerlands Beitr. z. Geophys. Supplementband I. pp.* 127–179, 1931.—A general review of recent observations on cosmic radiation. The chief sections of the paper are as follows: (1) Absorption laws deduced from measurements with ionisation chambers, (2) Measurements with counting tubes, (3) Influence of secondary rays, (4) Reduction of measurements at various heights and with different absorbing substances, (5) Various methods for determination of the absorption coefficients, (6) Results of observation from direct methods: (*a*) absorption in air, including balloon observations, (*b*) absorption in water, (*c*) absorption in lead, (*d*) absorption in gold, (*e*) measurement of the absorption coefficients with coincidences, (7) Results from indirect methods. Hitherto the absorption coefficient of cosmic radiation is best known for water, whereby the wide range of 8 to 240 m. below the summit of the atmosphere has been measured. The observations indicate at least two components, a hard and a weak, whose absorption coefficients differ by not less than one power of ten. The ratio of the energy currents of both components before entrance into the earth's atmosphere may be of the order of magnitude 1 : 100, and hence the hard component may constitute only 1 % of the total energy of the radiant flow in space. After reaching the atmosphere the proportion of the weak radiation grows ever less at first slowly, but then rapidly on account of the absorption of the weak rays. In balloon observations the weak component is predominant. A slow increase of the absorption coefficient with height takes place up to 6 km. Instead of a continual increase thereafter a pronounced maximum of the absorption coefficient occurs between 6 and 7 km., and thereafter a quick decrease so that the value of the coefficient at 9 km. is found to be about 50 % of the maximum. This behaviour may be identified with the phenomenon of the transition layers in elements of various atomic numbers. The values of the absorption coefficients from measurements in lead vary considerably, and at present it can only be said that in thicknesses of lead over 10 cm. they are comparable as to order of magnitude with those obtained from water. The single measurement in gold gives the same result. The indirect methods of measurement are not completely developed, but give so far satisfactory agreement with the water measurements. The direct methods themselves are not strictly direct, but rather results of calculations, based on more or less certain suppositions regarding absorption. A Bibliography with a list of 119 papers is given. J. J. S.

1697. Summary of the Year's Work, Department of Terrestrial Magnetism, Carnegie Institution of Washington. J. A. Fleming. *Terr. Mag.* 36. *pp.* 333–339, *Dec.*, 1931.—A research on the effects of pressure on the critical temperatures of ferromagnetic materials has been completed. The discussion of earth-current data at Watheroo, Huancayo and Tucson shows very close correlation between magnetic and earth-current disturbances. Construction has been begun on apparatus for automatically recording variations in the height of the Kennelly-Heaviside layer. Equipment is now in use for producing β- and γ-rays and high-speed protons. A method which employs the Geiger-Müller tube-counters provides a powerful means of investigating the nature and properties of cosmic rays. The Department's policy of co-operating with other investigators and organisations has been maintained. The fluctuations in the secular rate, particularly of the horizontal component, are found to follow closely the sun-spot cycle. In view of the proposed International Jubilee Polar Year, charts of northern regions have been prepared which exhibit a noteworthy unsymmetrical distribution of the intensity components with respect to the north pole. The area of feeble horizontal intensity extends in a long band from the northern part of Canada across to the most northern part of Siberia. The year covered is from July 1, 1930, to June 30, 1931. [See also Abstract 1624 (1931).] G. E. A.

CURRENT ELECTRICITY, MAGNETISM AND ELECTROMAGNETISM.

1698. Dilatation of Supraconductors. J. C. McLennan, J. F. Allen and J. O. Wilhelm. *Roy. Soc. Canada, Trans.* 25. *Sect. III. pp.* 1–12, *May*, 1931.—The coefficients of thermal expansion of lead and of the Pb-Bi-Sn alloy known as Rose's metal have been studied from 4° to 20° K. This range includes the points (7·2° and 8·5° K.) at which they become supraconductors, but no marked change was found in the thermal expansion coefficient at these points. Search was also made for a possible change in length, under the action of a magnetic field of strength sufficient to restore the electrical resistance when the metal was maintained below its transition point. No such effect was found. J. H. A.

1699. Electrical Conductivity of Ruthenium, Ruthenium Carbide and Tungsten Carbide. J. C. McLennan, J. F. Allen and J. O. Wilhelm. *Roy. Soc. Canada, Trans.* 25. *Sect. III. pp.* 13–26, *May*, 1931.—In earlier work, a sample of ruthenium showed supraconductivity at 2·04° K., and this result could not be reconciled with that of Meissner, who found none down to 1·13° K. The earlier result was therefore ascribed to the presence of an impurity, which, from the treatment, must have consisted either of carbon, tungsten or some compound between two or more of the three substances concerned. The first two suggestions are ruled out, however, from the measurements of Meissner. It was found that tungsten carbide, but not ruthenium carbide, is supraconducting below 2·05° K. J. H. A.

1700. Conductivity of Compressed Metal Powder. O. Kantorowicz. *Ann. d. Physik,* 12. 1. *pp.* 1–51, *Dec.* 22, 1931.—Pressures up to 4200 atmospheres were employed in the experiments. The resistance after compression differs more or less from that of the solid metal, the difference being less for soft powders and greater for hard substances. The powders are altered by compression, the material being hardened, and the connection between the resistance and the experimental conditions is complicated. The resistance depends not only on the actual pressure, but also on the previous history of the sample in the experiment. During a compression the resistance R can be represented within wide limits by an equation $1/R = c\sqrt{P} + C$, where c and C are constants, which are strongly dependent on the previous treatment. A sudden increase in c above a critical pressure may indicate a flow in the solid. A large number of details are given in the original paper. H. N. A.

1701. Electronic Conductivity of the Oxides of Copper. M. le Blanc and H. Sachse. *Ann. d. Physik,* 11. 6. *pp.* 727–735, *Nov.* 10, 1931.—This paper follows two previous ones in which were discussed the circumstances under which considerable electron conductivity occurs in the case of solid oxides. In the experiments described in the present paper the temperature course of the specific conductivities of Cu_2O and CuO between 20° and 400° C. was measured by test bodies of similar density of packing and size of particles. The conductivity of Cu_2O lies at 20° about 5, at 400° about 1½ powers of ten below that of CuO. Hence it is concluded that Cu_2O, analogously with the badly conducting monoxides NiO and MnO, is the normal oxide of copper. The formation of CuO by the taking up of oxygen leads to the seizure of an electron of the inner shell and the giving up of an electron of conduction. If O is allowed to act upon freshly produced Cu_2O which exists in a vacuum, then a rise of conductivity about 3 powers of ten upon 10^{-6} occurs. On pumping away the gas this does not go back, but can be made reversible only by heating *in vacuo* at 250° C. With H or N the effect does not occur. If these gases are brought to the Cu_2O of conductivity 10^{-6} then a comparatively small influence on the conductivity is observed. Observations on the isothermal changes of conductivity taking place on the transition $Cu_2O \rightleftharpoons CuO$ agree with this conclusion. [See following Abstract.]
J. J. S.

1702. Electronic Conductivity of Solid Oxides. M. le Blanc and H. Sachse. *Phys. Zeits.* 32. *pp.* 887–889, *Nov.* 15, 1931.—The electronic conductivity of various solid compounds is discussed, especially the oxides of Mn, Co, Ni, Cu, In, U and the oxides of the metals of the platinum group. A summary is given of results previously published [see preceding Abstract]. J. J. S.

1703. Conduction Electrons and Photoelectrons in Insulators and Semi-Conductors. B. Gudden. *Phys. Zeits.* 32. *pp.* 825–833, *Nov.* 1, 1931. —A review of recent papers on this subject, dealing chiefly with two questions: (1) the mechanism of non-metallic electronic conduction and (2) the origin of conduction electrons. The discussion is restricted to crystalline substances of simple chemical structure. Liquids and technical insulators and half-conductors are not dealt with. Ionic conduction in solids is also not considered. J. J. S.

1704. Conduction and Photoelectric Effects in Blocking Layers. W. Schottky. *Phys. Zeits.* 32. *pp.* 833–842, *Nov.* 1, 1931.—A discourse dealing with the phenomena which have been observed in the places of contact between two differing electronic conducting bodies. An example of this is loose or clinging contact between Se, PbS or Cu_2O and a metal. If between a half-conductor and a metal an electric tension is set up there appears at the places of contact, and also probably within submicroscopic distances, a special transition resistance which markedly exhibits an extraordinary difference for different directions of current. For the layer in which these transition resistances (important for rectifying action) are formed the name blocking layer has been given. This layer is also important in the case of the blocking-layer photoelectric effect investigated in recent years. This paper gives a summary of the work on this subject from the time of Braun, who in 1874 studied this dry detector effect of metallic contacts with FeS_2, PbS and some complex compounds. The effect never occurs between two clean metals, but always between metals and so-called semi-conductors. Various investigations of the author and other observers are referred to, including the recent work of van Geel [see Abstract **3554** (1931)] and the new theory of C. Wagner [see Abstract **195** (1932)]. The case chiefly dealt with is that of Cu_2O in contact with various substances and a series of resistance curves is given. The photoelectric effect is discussed, and the author regards it as probable that the photoelectrons can experience a large number of collisions without again being absorbed, and that after a very great number of collisions they are still capable of penetrating the blocking layer. It is probable that between the electrons of the internal photoelectric effect and the electrons of the blocking layer there exists not only a connection but full identity, and that the blocking-layer photoelectric effect roughly expressed is a diffusion effect connected with the limited duration of life of the internal photoelectrons. J. J. S.

1705. Conduction and Photoelectric Effects. F. Bloch. *Phys. Zeits.* 32. *pp.* 881–886, *Nov.* 15, 1931.—A theoretical discussion and explanation of the phenomena of conductivity in metals and of the photoelectric effect founded on the principles of wave mechanics. The new electron theory of metals has succeeded in explaining many characteristic peculiarities of metals upon the assumption that under the action of the ions of the crystal lattice and of the remaining electrons each electron exists in a periodic field of force so long as it moves in the interior of the metal. Based on this presentation wave mechanics explains the existence of " free " conduction electrons, *i.e.*, the great mobility of the electrons in the interior of metals which previously was assumed without explanation. It depends on the periodicity of the potential, and thus it is explained how a disturbance of this periodicity, such as, for instance, is caused by thermal lattice oscillations, produces a lessening of the mobility of the electrons and therewith a resistance which increases with the temperature. Accurate calculation on these lines shows a satisfactory agreement with the results of observation. J. J. S.

1706. Influence of X-Rays and γ-Rays upon the Conductivity of Paraffin. F. Seidl. *Zeits. f. Physik,* 73. 1–2. *pp.* 45–61, *Nov.* 24, 1931.—The specific resistance of paraffin from the melting point 50 ± 1° C. was determined, with special consideration of the production of the preparations used in the measurements, and the influence of X-rays and γ-rays upon the paraffin was investigated. It was found that the increase of conductivity which occurred is to be ascribed not to an electrification by absorbed β-rays, but to an ionisation due to the secondary β-radiation liberated by the γ-radiation. J. J. S.

1707. Hall Effect in Weak Fields. M. Cantone and E. Bossa. *Reale Accad. d'Italia, Mem.* 2. 1. (*Fis.*), [31 *pp.*], 1930.—An extension of the study of E. Bossa on this subject [see Abstract 3211 (1930)] with improved and more sensitive apparatus in which various sources of error were eliminated. Bossa's experiments, however, were limited to Fe, Ni and Cu, and did not extend to very feeble fields. In these by means of an amplifying system with a thermionic valve it was possible to raise to a thousand the factor of multiplication of the p.d.s at the points of attachment of the wires from a Hartmann and Braun's galvanometer of ordinary type. Thus values to 10^{-10} volt could be estimated ballistically in the instantaneous communications of the lamina subjected to experiment, a rigorous control being carried out by a potentiometer method. A defect in the arrangement arose from the fact that disturbances, meteorological or due to tramway currents, were magnified. In the experiments described in the present paper the elimination of external disturbances is described. By means of a compensation method the effect of the earth's field was eliminated. The success of these corrections was greater than was expected, and the research was extended to various substances: Fe, Ni, Bi; various samples of these, Te, Sb, Ag, Au, Pt, Pd, Al, Cd, Zn, Sn, Pb, Ta, Mg, various specimens of Cu of different shapes, and different alloys of Fe and Ni, specimens of steel tempered and untempered and re-tempered in oil, as well as slightly ferromagnetic alloys CoNi, manganin, constantan and argentan. J. J. S.

1708. Obstructed Arc Discharge. P. Bächtiger. *Helv. Phys. Acta,* 4. 6. *pp.* 409–427, 1931. *In German.*—The obstructed arc discharge (electrodes close together in discharge-tube so that ordinary phenomena round anode and kathode no longer appear) has been investigated in nitrogen [see Abstract 1645 (1931)]. The conclusions reached are investigated quantitatively in the present paper. In an arc discharge in nitrogen with tungsten electrodes at 180 mm. pressure the potential drop is measured for different electrode distances. From the curves is obtained the minimum voltage U_M and the electrode distance D, which are associated with a steep potential-drop ΔU. Using energy equations it is shown that ΔU is to be regarded as a decrease in the anode drop. The increase in D is approximately proportional to $\sqrt{U_M}$. The use of anodes having different heat conductivities shows that D is dependent on the anode temperature. Similar observations were made in hydrogen; here the increase in D is proportional to U_M. A. C. M.

1709. Anomalous Variations of the Sparking Potential as a Function of p_0d. F. M. Penning. *K. Akad. Amsterdam, Proc.* 34. 9. *pp.* 1305–1313, 1931.—The curve connecting the sparking potential of a gas with the product p_0d, where p_0 is the pressure of the gas at 0° C. and d

is the distance apart of the electrodes, usually has a single minimum. It runs sharply up at low values of p_0d and more slowly at high values. Anomalous cases occur with helium, and with mixtures of argon and neon, the curve in the latter case having two minima, with an intermediate low maximum. With helium, for a certain region below the ordinary minimum on the curve, there are three sparking potentials for a given value of p_0d. J. H. A.

1710. Time Lag of the Electric Spark. J. A. Tiedeman. *Physics*, 1. *pp.* 354–365, *Dec.*, 1931.—The variation in the time lag of the electric spark has been investigated as a function of the applied field and the number of electrons liberated at the kathode by ultra-violet light during the application of the field. The time intervals were measured by a Lichtenberg figure method with a precision of 5×10^{-10} sec. A biasing positive potential was applied to the zinc kathode in such a way that not only were the residual ions removed from between the electrodes before the application of the field, but a known number of electrons could be liberated from the kathode by ultra-violet light while the field was applied. For the case of air, hydrogen and nitrogen curves are given showing how the time lag decreases with an increase in the number of electrons liberated during the application of the field. It is shown that with comparatively high applied fields the time lag reduces to approximately the time required for an electron to be liberated in the gap. AUTHOR.

1711. Unusual Action of Mercury-Vapour Glow Lamps without Voltage. H. Heyne. *Zeits. f. techn. Physik*, 12. 10. *pp.* 495–498, 1931.—By means of a kathode-ray oscillograph the current history of a small spark-gap operating on 3kV was studied, and the influence of radium radiations was shown normally to have a marked effect. When a small quartz mercury-vapour lamp, not connected to a voltage supply, was brought near the gap, it was found that the discharge was considerably modified. It is considered possible that the mercury-vapour lamp emits some form of photoelectric radiation when under the influence of radium radiations. G. E. B.

1712. Velocity Spectrum of Normal Gaseous Ions in Air and the Problem of Ionic Structure. L. B. Loeb and N. E. Bradbury. *Phys. Rev.* 38. *pp.* 1716–1729, *Nov.* 1, 1931.—Considering the evidence of various observers, it is found that while ions at ages from 0·5 to 2 sec. show so-called spectra of ionic mobilities, this is not necessarily the case for normal ions studied over short-time intervals. The work of Loeb [see Abstract 207 (1932)] and Luhr shows that active molecules probably pick up the original charged carrier by electrochemical forces. Such products may be produced in air by ionising agents or may be impurities. These velocity spectra will therefore vary with the relative and absolute concentrations of the active molecules and with experimental conditions. It is believed that the greater portion of the lowering of mobility is due to the usually assumed force of dielectric polarisation as found by Langevin's equation, although it is not true for the close approach of ion and molecule. These two effects are sufficient to account for all the phenomena observed without a very significant change in the ionic mobility. H. M. B.

1713. Mobility of Positive Ions in Helium. Part I. Helium Ions. A. M. Tyndall and C. F. Powell. *Roy. Soc., Proc.* 134. *pp.* 125–136, *Nov.* 3, 1931.—In a previous paper the authors have shown that minute traces of impurity profoundly affect the ion mobility. They have now constructed a new apparatus, adapted to work at lower pressures, which reduces the effect of small traces of impurity. Pressures of 20 to 60 mm. of mercury are employed, instead of 360 mm. New oscillators were necessary, covering a range up to 50,000 ~, instead of 6000 ~, as previously used. Instead of α-rays from polonium a glow discharge was used to ionise the gas. This had several advantages. Curves show the definite effect produced with pure helium, and the separate maxima due to He^+ and Hg^+ with mercury vapour at a concentration of 1 in 70,000 admitted by removing a liquid air trap. Some curves were also obtained in krypton. An apparatus for the determination of absolute values of the mobility of the ions was finally constructed. In this the distance between the two grids could be altered continuously. The result was that, when the current was plotted with respect to this distance, a series of peaks was obtained the distance between which was the distance travelled by the ion in one period. The mobility of positive ions of helium in pure helium was found to be 21·4 cm./sec./volt/cm. at 760 mm. of mercury and 20° C. H. N. A.

1714. Mass of Positive Ions in a Glow Discharge. O. Luhr. *Phys. Rev.* 38. *pp.* 1730–1738, *Nov.*, 1931.—An attempt is made to determine directly the mass of gas ions in air, N_2, O_2 and SO_2. The ions formed in a gas discharge drift slowly through 2·5 cm. and pass as a molecular beam through a slit 0·01 mm. by 5·0 mm., where the mass spectrum is analysed by apparatus of the Dempster type. The pressure in the drift space is maintained at 0·1 to 0·5 mm. of mercury. The following ions appear in large quantities N^+, N_3^+, O^+, O_2^+, SO_2^+ and $H_2SO_3^+$. Also there is a smear of larger ions, more pronounced in air, indicating the presence of such ions as $2N_2^+$, $N_2O_2^+$, $2O_2^+$, $N_2O_3^+$ and heavier combinations. It seems likely that air ions aged over a considerable period are of a complex and heterogeneous nature, while the ions in pure gases are monatomic, diatomic and triatomic, except for the attachment of impurities. H. M. B.

1715. Ionisation of Inert Gases by Slow Alkali Ions. O. Beeck and J. C. Mouzon. *Ann. d. Physik,* 11. 6. *pp.* 737–740, *Nov.* 10, 1931.—A further account of the investigation of this subject which was described in a former paper [see Abstract 952 (1931)]. In the present note the experiments on krypton and xenon are described. The main result obtained is stated, *viz.*, that the inert gas atom is most easily ionised by that alkali ion which stands nearest to it in the periodic system, thus having approximately the same mass and the same number of electrons in the shell. Krypton forms an exception which, under about 400 volts, is more strongly ionised by K^+ than by Rb^+. The ionisation yield in an inert gas by the alkali ion nearest to it in the periodic system increases with the mass of the inert gas atom. The high ionisation yield of K^+ in krypton in comparison with the output of Rb^+ and the fact that K^+ in xenon is better ionised than Rb^+, and Li^+ better than Na^+, complicates considerably the general result, but it is possible that as regards the main result above stated the maximum formation may be more a question of the electron configuration than a pure mass effect. [See following Abstract.] J. J. S.

1716. Ionisation of Inert Gases through Collision with Positive Alkali Ions. O. Beeck and J. C. Mouzon. *Phys. Rev.* 38. *pp.* 967–968, *Sept.* 1, 1931. *Ann. d. Physik*, 11. 7. *pp.* 858–862, *Nov.* 23, 1931.—A description is given of continued experiments on the ionisation of gases [see preceding Abstract]. The previous work has been extended to Kr and Xe, using velocities up to 600 volts, and the existence of a definite threshold of action has been studied for Ne, A, Kr and Xe. The apparatus used by Beeck in the earlier experiments was employed. The facts discovered show that these collision phenomena are even more complicated than was previously expected. Moreover, it is found that the maximum efficiency of ionisation for a given accelerating potential increases with the atomic number of the gas. There is a definite threshold at which ionisation begins. This was studied in the case of the gases named above. The results obtained are thus summarised: (1) The ionisation of the inert (or noble) gases by positive alkali ions sets in at very various and unexpectedly high potentials, in many cases with remarkable sharpness. (2) Analogously with the results obtained on the yield of the ionisation [see Abstract 952 (1931)] the threshold of the ionisation in an inert gas through collision with alkali ions is at the lowest in that alkali ion that is nearest to the inert gas in the periodic system, here also K^+ in Kr is an exception. (3) With an inert gas there exists the relation that the threshold of the ionisation is the steeper the lower the threshold potential is, which on the other hand corresponds with a greater yield at higher velocities. The results found in their present form do not disagree with the earlier theoretical considerations of Frank, Joos and Kulenkampf and Eckart. J. J. S.

1717. Auto-Ionisation in the Alkaline Earth Metals and the Inert Gases. H. E. White. *Phys. Rev.* 38. *pp.* 2016–2020, *Dec.* 1, 1931.—The atomic process of auto-ionisation put forward by Shenstone [see Abstract 571 (1932)] is discussed in connection with the alkaline earth metals, Ca, Sr and Ba, and the inert gases Kr and Xe. The phenomenon is quite similar to the Auger effect in X-rays and analogous with the predissociation of molecules in band spectra put forward by Kronig. Certain characteristics of energy levels in Ca and Sr, known to lie above the first series limit and to give rise, in combination with lower levels, to sharp and nebulous lines, are attributed to the process of auto-ionisation. In a similar manner the cutting off at the first or second member of certain series of lines in Kr and Xe and the continuance of other series of the same electron configurations to five, six, seven and eight members is attributed to the process of auto-ionisation in those atomic states of the neutral atom which lie above the first series limit. AUTHOR.

1718. Production of Heavy High-Speed Ions without the Use of High Voltages. D. H. Sloan and E. O. Lawrence. *Phys. Rev.* 38. *pp.* 2021–2032, *Dec.* 1, 1931.—A method is described for the multiple acceleration of heavy ions to high speeds without the use of very high voltages. The ions travel through a series of metal tubes in synchronism with an oscillating electric potential applied alternately to the tubes so that the electric field between tubes is always in a direction to accelerate the ions as they pass from the interior of one tube to the interior of the next. Using 30 such tubes and a h.f. voltage of 42,000 volts on a wavelength of 30 m. a current of 10^{-7} ampere of 1,260,000 volt singly charged Hg ions was obtained. A modified type of apparatus now under construction will have two power oscillators driven by a single master oscillator, one feeding the first 36 accelerator tubes and the second feeding 20 additional ones. It is estimated that an average current of more than 10^{-7} ampere should be obtained of 4,500,000-volt singly-charged Hg ions. With multiply charged ions this value should be considerably increased. A. W.

1719. Possibility of Proof of Electron Spin. O. Klemperer. *Phys. Zeits.* 32. *pp.* 864–866; *Disc., p.* 866, *Nov.* 1, 1931.—A method of measuring the number of electrons scattered through 45° by celluloid foil is described. If the number of electrons scattered through a given angle is calculated assuming (1) no spin, (2) spin, the difference is greatest for an angle of 45°. A graph is given whose ordinates are numbers of electrons and abscissæ percentages of initial energy. This shows maxima at 100 % and 50 % of initial energy. The height of the second maximum, which is due to inelastically scattered electrons, is less than that expected from classical (Darwin) and quantum mechanical theory (Mott). The author attempts to explain this effect by assuming the existence of electrons, some of which (*programmässige*) obey a simple impact law and some (*unprogrammässige*) which do not. In the *Discussion* **E. Guth** asserts that if the inelastic scattering of electrons is treated relativistically, the theoretical and experimental results agree well and there is no need for any special assumptions. N. D.

1720. Angular Distribution of Slow Electrons Scattered by Gas Molecules. C. Ramsauer and R. Kollath. *Phys. Zeits.* 32. *pp.* 867–870, *Nov.* 1, 1931.—The distribution of electrons scattered elastically by various atoms is determined for various angles and various (slow) speeds of the electrons. The gases used were argon, hydrogen and carbon dioxide. It was found that no relationship existed between the form of the curves giving the angular distribution and the values of the effective cross-sections for the gases so far investigated. H. L. B.

1721. Electron Interferences in Crystal Lattices. F. Kirchner. *Ann. d. Physik,* 11. 6. *pp.* 741–760, *Nov.* 10, 1931.—An improved technique for producing electron interferences is described. A simple apparatus is sketched, which may be applied in many different ways. In testing the wave-mechanical relation $\lambda = h/mv$ it is shown that the interference photographs are so sharp that it is easy to achieve an accuracy of a few tenths of 1 % in measuring them out. The measured wave-length does not agree with that calculated from de Broglie's relation; a probable cause is the difficulty of accurately measuring the potential drop of the electrons. A lower limit of 1000 is obtained for the resolving power of the lattice. The question of the nature of the spectrum that results when 10^{-3} cm. Al foil has been traversed is also discussed. H. L. B.

1722. Interpretation of Energy Losses of Moderately Fast Electrons in Nitrogen and Carbon Monoxide. E. Rudberg. *Ann. d. Physik,* 11. 7. *pp.* 802–816, *Nov.* 23, 1931.—By means of a method of electrostatic deflection the author succeeds in finding various critical potentials in nitrogen. The results are compared with those of other authors (Renninger, Birge, Hopfield). Energy losses in carbon dioxide are determined by the same apparatus. The position of the most pronounced maximum agrees excellently with the position calculated on the

assumption that the lowest singlet state is excited. The appendix contains a short quantum-mechanical treatment of the theory used in predicting the relative frequency with which the various transitions occur.
H. L. B.

1723. Electron Temperatures in Inert Gases. R. Seeliger and R. Hirchert. *Ann. d. Physik,* 11. 7. *pp.* 817–857, *Nov.* 23, 1931.—Amongst the results of the researches of Langmuir and his helpers one of the most important is that which shows that the electron velocities in gas discharges are distributed according to Maxwell's law and that thus analogously with the classical principle of the kinetic theory of gases a "temperature" T can be ascribed to their random kinetic energy. Numerous papers—about 60—have been published up to the present dealing with this and related problems in which the method of Langmuir's sounds was employed for investigation. The authors by systematic examination with various gas densities, current strengths and widths of tube, have sought to obtain trustworthy and reproducible results, of a quantitative nature, for the electron temperature appears to be extraordinarily sensitive to any impurities in the discharge tube. Attention has been paid to the unstratified positive column whose characteristics are specially important for the theory of electron motion in gases. As regards the "temperature" T of the electrons which is defined in the usual way by $m\bar{v}^2/2 = 3\,\mathrm{KT}/2$ and is always expressed in volts in accordance with the conversion factor 1 volt = 7750° Abs., further information on this temperature can be obtained in indirect ways from the characteristic of a Langmuir sound. The methods and results of the experiments on this subject are fully discussed in the present paper which deals with preliminary researches, the chief investigations, including the mean values of the electron temperatures, radial temperature distribution, measurements of the gradients, carrier current densities, deviations from the Maxwell distribution, and concludes with a list of the papers on electron temperatures hitherto published.
J. J. S.

1724. Emission of Secondary Electrons from Tungsten. A. J. Ahearn. *Phys. Rev.* 38. *pp.* 1858–1870, *Nov.* 15, 1931.—Critical potentials are measured in the emission of secondary electrons from tungsten, using an electron-gun in an exhausted tube. After cleaning-up processes had been gone through, maxima were recorded at about 3·5 and 8 volts, and slope increases at 24, 33 and 70 volts. The phenomena may be associated with the diffraction of electrons on the production and absorption of characteristic soft X-rays. Regardless of the mechanism operating at the critical potentials, their decrease or elimination beyond 40 volts points strongly to effects of surface contamination rather than to characteristics of tungsten.
A. C. M.

1725. Gas Concentration in Electron Beams. W. Ende. *Phys. Zeits.* 32. *pp.* 942–945, *Dec.* 1, 1931.—In continuation of earlier work [see Abstract 607 (1931)], the discharge tube and its operation are described. An explanation of the effect is given on the lines of Johnson's theory, and the relation of the position of nodes formed in the light beam to current, pressure and volt-velocity is discussed.
F. S.

1726. Photoelectrons and Negative Ions. E. M. Wellish. *Roy. Soc., Proc.* 134. *pp.* 427–444, *Dec.* 2, 1931.—It is investigated experimentally whether, during the passage of a beam of electrons through a gas, a fraction of them becomes attached to the molecules, thus producing negative ions. Photoelectrons are exposed to an alternating p.d. of square wave-form, using electrodes 2 cm. apart. The steady current i_0 and the currents i_1 and i_2 corresponding to frequencies of about 30 and 600 ∼ are measured for a given gas pressure and various potential differences V. The ratios i_1/i_0 and i_2/i_0 plotted against I/V give curves which are compared with theoretically derived curves. It is concluded that most of the negative ions are formed near the electrode at which the electrons originate. Those electrons which do not form negative ions near that electrode generally cross to the other electrode in the free state. N. D.

1727. Lateral Space Distribution of X-Ray Photoelectrons. P. Kirkpatrick. *Phys. Rev.* 38. *pp.* 1938–1942, *Dec.* 1, 1931.—The lateral distribution in space of the directions of emission of photoelectrons ejected from argon atoms by partially polarised X-rays having the mean wavelength 0·53 Å. was determined by examination of photographs of 2008 condensation tracks produced in a Wilson expansion apparatus. Discarding by a definite analytical procedure the isotropically distributed emissions, which are ascribed to unpolarised radiation, the distribution of the remaining 752 tracks is found to be in excellent agreement with the indications of quantum mechanics that (for K electrons) the probability of emission is proportional to the square of the cosine of the angle between the electric vector of the absorbed radiation and the projection of the direction of emission upon a plane normal to the direction of incidence. AUTHOR.

1728. Photoelectric and Thermionic Emission from Cobalt. A. B. Cardwell. *Phys. Rev.* 38. *pp.* 2033–2040, *Dec.* 1, 1931.—The total photoelectric emission from a strip of cobalt foil excited by the undispersed radiation from a quartz-mercury arc was studied during an extended outgassing process and after stable conditions had been reached. The sensitivity rose quickly in the initial period, then decreased to a stable value. A change in the long-wave limit consistent with the change in the sensitivity was observed. Curves are plotted showing the variation of the full arc sensitivity with temperature. At a temperature near 850° C. abrupt changes in these curves were observed. X-ray analyses seemed to indicate that this resulted from a structural change. The long-wave limit for cobalt which had been cooled suddenly from above 850° C. and which was known by X-ray analysis to have a face-centred cubic structure was between 2967 Å. and 3022 Å. (4·25 ± 0·08 volts). A sample which was cooled slowly from above 850° C. and which was known from X-ray analysis to have a hexagonal close-pack structure had a long-wave limit between 2757 Å. and 2967 Å. (4·12 ± 0·04 volts). A plot of the thermionic current as a function of temperature indicates that there is an abrupt change in the Richardson (*A*) or (*b*) and perhaps both at a temperature near 850° C. AUTHOR.

1729. Photoelectric Properties of Tantalum. A. B. Cardwell. *Phys. Rev.* 38. *pp.* 2041–2048, *Dec.* 1, 1931.—The true threshold of tantalum, calculated from the curves according to the theory of R. H. Fowler [see Abstract 3584 (1931)], is at 2974 Å. For wave-lengths near the threshold, there is a great increase of the photoelectric emission with the temperature. E. E. F. d'A.

1730. Photoelectric Cells for Sound Films. W. Kluge. *Zeits. f. techn. Physik*, 12. 12. *pp.* 649–661, 1931.—Describes the various methods of preparing photoelectric cells. A thin layer of cæsium on cæsium oxide and silver shows the furthest extension of the spectrum towards the red. In a Nitra lamp giving 40 μA per lumen about half the total current is cut off by shielding off all but the red spectrum. Below the critical glow voltage of 120 the current is proportional to the light. As regards frequency, the cells show an independence of light response of pitch up to 3000 hertz, or in cases of the most favourable adaptation up to 5000 hertz. After that point the curve droops slightly. The rushing noises sometimes heard when the cell is in operation must be attributed to unevennesses in the film, to the granular character of the silver, to the amplifier and to the photoelectric cell if worked at too high a voltage. E. E. F.d'A.

1731. Optimum Outputs of Photoelectric Devices. E. D. Wilson. *Rev. Sci. Instruments*, 2. *pp.* 797–806, *Dec.*, 1931.—The terms power sensitivity and voltage sensitivity are defined for photoelectric elements in a circuit, and a mathematical expression is derived to evaluate each of these characteristics for the three classes of light-sensitive devices. Curves are plotted for comparing the outputs with one another for various intensities of light flux. AUTHOR.

1732. Experiments with Gasfilled Cs-O-Ag Photoelectric Cells. K. H. Kingdon and H. E. Thomson. *Physics*, 1. *pp.* 343–351, *Dec.*, 1931.—The amplification of the kathode emission by argon is much greater for a tube with a photo-kathode than for a tube of similar geometry equipped with a thermionic kathode. This difference is attributed to large secondary electron emission by positive ion bombardment of the photo-kathode. If the anode voltage of one of these argon-filled tubes is abruptly increased, the time-lag in the resulting current change is of the order 5×10^{-5} sec. for the thermionic tube, but of the order 10^{-3} sec. for the photo-tube. This lag is attributed to the life of the positive ion charge on the spongy surface of the photo-kathode. Measurements of the spontaneous fluctuations in the current through a gasfilled photo-tube indicate that the " noise " is of low frequency and associated with the gas amplification effect. AUTHORS.

1733. Photo-Thermionic Effect due to Red and Infra-Red Radiation. I. Ranzi. *N. Cimento*, 8. *pp.* 331–337, *Nov.*, 1931.—The thermionic emission from a tungsten filament is found to increase when it is irradiated with infra-red or red light, but it is not believed to be a thermionic action throughout the whole mass of the filament. The speed of the effect is independent of the size of the kathode and the variation in the intensity of the light is followed up to 1500 per sec. It is probable that the effect takes place in a thin layer of the kathode surface, where, according to the theory of Schottky on the small shot or flicker effect at low frequencies, heterogeneous particles are found which disturb the thermionic emission. H. M. B.

1734. Thermionic Emission and Electrical Conductivity of Oxide Kathodes. A. L. Reimann and L. R. G. Treloar. *Phil. Mag.* 12. *pp.* 1073–1088, *Dec.*, 1931.—Experiments are described which form a continuation of the work initiated and discussed by Reimann and Murgoci [see Abstract 2921 (1930)]. A more accurate method has been employed for measuring conduction phenomena in oxide kathodes, and new information has been obtained on (1) the variation of the conductivity of the coating and of the thermionic emission with temperature, (2) the relation between the conduction current and electrode potential difference at various temperatures, (3) the relation between the thermionic current and anode potential at various temperatures. The theoretical position is discussed in the light of this new knowledge together with the results of recent work by other observers. It is concluded that the weight of experimental evidence is still in favour of the theory of the mechanism of these kathodes according to which the current, thermionically emitted at the surface of the core metal, is carried almost exclusively by Ba-ions through the coating, at the outer surface of which it is re-emitted thermionically. AUTHORS.

1735. Origin of Enhanced Emission of Oxide-Coated Films. J. A. Becker and R. W. Sears. *Phys. Rev.* 38. *pp.* 2193–2213, *Dec.* 15, 1931.—In 1929 Becker proposed a theory [see Abstract 1590 (1930)] of oxide-coated filaments, according to which both barium and oxygen diffused to and from the surface into the oxide. In the present paper the authors investigate the origin of the thermionic electrons which convey the current. They used a filament made of an alloy called " konel," consisting of nickel, cobalt, iron and titanium. The activity depends upon the concentration of the barium (strontium, calcium) and oxygen on the outer oxide surface and upon the amount of barium diffused through the oxide. E. E. F. d'A.

1736. Direct Crystal Control for Ultra-Short Waves. H. Straubel. *Phys. Zeits.* 32. *pp.* 937–941, *Dec.* 1, 1931.—Owing to practical considerations the use of quartz crystals for direct control of transmitters is confined to wave-lengths greater than 40 to 50 m. For shorter waves frequency multiplication is generally employed, necessitating screening and neutralising arrangements between the various stages. The author has found that tourmaline gives oscillations of very pure form and hardly shows any spurious frequencies, such as are so frequently found with quartz crystals, particularly when the thickness is small. For equal thicknesses tourmaline gives a frequency about 35 % higher than quartz, and it has been found practicable to grind a tourmaline plate to control directly a 7 m. transmitter of 5 watts power. The temperature coefficient of tourmaline is about 10 % higher than that of quartz. Between 20° and 60° C. a change of frequency of $-46\cdot6$ parts in 10^6 per 1° C. was found. A. W.

1737. Measurement of Radiation Pressure on Resonators in an Electromagnetic Field. K. Fritz. *Ann. d. Physik*, 11. 8. *pp.* 987–1016, *Dec.* 8, 1931.—Measurements were made of the radiation pressure on a resonator in the form of a straight wire of length $\lambda/2$, for both damped and undamped waves. The wave-lengths used were 112, 180, 204 and 245 cm. and these gave radiation pressures of 10^{-5} to 10^{-3} dyne. Calculations were also made from the power received (W), which was derived from the heat developed at the centre of the antenna, using the formula $k = W/c$, c being the velocity of light. The difference between the calculated and directly measured values of k did not exceed 6 % when suitable precautions were taken. Further experimental work showed that the current distribution along the antenna was not of pure sine form. The distribution was accurately measured for a wave-length of 204 cm. A. W.

1738. Theory of Ferromagnetism. T. Hirone and T. Hikosaka. *Zeits. f. Physik*, 73. 1–2. *pp*. 62–73, *Nov*. 24, 1931.—Heisenberg's theory [see Abstract 2835 (1928)] gives some interesting conclusions in connection with the conditioning factors of ferromagnetism: (1) The number z of the directly neighbouring atoms in the crystal at a point in the lattice ≥ 8, (2) the exchange integral $J_0 > \frac{kT}{2}$, and (3) the chief quantum number of the valency electron, $n \geq 3$. The authors give an improved modification of Heisenberg's theory in which in place of the gauss terminal distribution form in each term system, on which the theory was based, a general distribution is assumed. From this improved theory it results that the conditioning factors for the number of the neighbouring atoms and the magnitude of the exchange energy for the setting up of the ferromagnetism are somewhat different from those of Heisenberg, and capability of magnetisation is strongly influenced by the number of the atoms which are connected with each other, and form a closed system in the crystal (elementary complex). The relation between magnetisation and temperature agrees well with experiment. J. J. S.

1739. Magnetic Properties and Crystalline Structure of Anhydrous Cobalt Sulphate. R. Hocart and (Miss) A. Serres. *Comptes Rendus*, 193. *pp*. 1180–1182, *Dec*. 7, 1931.—Sulphate I, obtained by calcination of the hydrated crystals at 400° C., has a magnetic moment of 25 magnetons. Sulphate II, obtained by calcination at 700° C., has a magnetic moment of 26 magnetons. Sulphate II′ is obtained by crystallisation in ammonium bisulphate, and has 26 magnetons like II. The authors have obtained Debye-Scherrer spectra of all three sulphates, and find that they are all crystallised, though the crystals of I and II are sub-microscopic. The spectra of II and II′ are identical. The crystals of II′ are visibly orthorhombic; the rotating crystal method gives $a = 4{\cdot}6_5$ Å., $b = 0{\cdot}7_1$ Å., $c = 8{\cdot}4_5$ Å. The salts I and II have spectra with practically the same parameters, but the relative intensities of the lines are not identical. The dimensions of the lattices are practically identical, but the structures are different, as is also indicated by the difference between the magnetic properties. H. N. A.

1740. Relationship between the Barkhausen and the Wiedemann Effects. W. Brandt. *Zeits. f. Physik*, 73. 3–4. *pp*. 201–202, *Dec*. 2, 1931. —A continuation of an earlier study on the Barkhausen effect and Barkhausen impulses. A wire, non-magnetised in the longitudinal direction, is by impulsive alteration of the longitudinal magnetic field caused to alter its magnetisation by "Barkhausen jumps" or impulses, so that by the impulsive potential in the wire of a coaxial coil the effects are detectable and measurable. The converse is also true, namely the introduction of a ferromagnetic wire into an impulsively varying circular field, results in axial potential impulses which can be measured. This is done on a nickel wire and the details described. The effect of torsion is also investigated and results in formulæ expressing the three possible conditions. Torsional, longitudinal and circular effects T, L and C respectively, of a ferromagnetic wire may be combined as: (1) $L + T = C$, (2) $T + C = L$ and (3) $Z + L = T$. If two of these are kept constant and the other varied, then the alteration will be due to the variable one only. Alter C and an axial impulse results, alter L and an impulse follows in the coaxial coil. These two combined give the combination of the Barkhausen and Wiedemann effects above mentioned.

S. G. B.

1741. Effect of Magnetisation on the Elastic Modulus by Extensional Vibrations of Ferromagnetic Bars. E. Giebe and E. Blechschmidt. *Ann. d. Physik*, 11. 8. *pp.* 905–936, *Dec.* 8, 1931.—The change in the elastic modulus caused by a magnetic field was obtained from the change in the frequency of longitudinal vibrations, the bars being set in vibration by a special electrical resonance method. Commercially pure nickel was tested in the forms hard, medium and soft, and also certain nickel alloys. The ΔE effect (change per unit of E) exhibits hysteresis, saturation and remanence. For the three nickel bars the observed maximum changes were 0·0077, 0·054 and 0·132. It is found that the ΔE effect varies as the intensity of magnetisation and inversely as the coercive force. The damping of the bars was deduced from the resonance curves; when the damping is large, the ΔE effect is also large. There is no simple relation between the ΔE effect and the Joule effect. In the hard nickel rod the ΔE effect has opposite signs for longitudinal and transverse vibrations; in the nickel alloy "indilatans" the effect is positive for both modes of vibration. Certain practical applications of the method to h.f. technique are indicated [see also following Abstract]. G. E. A.

1742. Hysteresis Phenomena of Magnetostriction. A. Schulze. *Ann. d. Physik*, 11. 8. *pp.* 937–948, *Dec.* 8, 1931.—When the changes in the modulus of stretching are plotted as a function of the magnetic field, evidence of hysteresis is obtained. Three specimens of nickel were investigated which had undergone different kinds of previous heat treatment. In each case magnetostriction hysteresis was noted. Hysteresis was also observed in cobalt. The relation of the magnetostriction to the relative intensity of magnetisation was also studied. [See Abstracts 189 and 1054 (1928).] G. E. A.

1743. Magnetic Moment of Tetravalent Cobalt. (Miss) A. Serres. *Comptes Rendus*, 193. *pp.* 1327–1328, *Dec.* 21, 1931.—The magnetic susceptibility of magnesium cobaltite, $MgCoO_3$, has been determined from $-182 \cdot 7°$ to $549 \cdot 4°$, $1/\chi$ is linearly related to temperature above 233°; the Curie point is $-164 \cdot 5°$ Absolute, the Curie constant 4·261, and the magnetic moment of Co^{iv} 29 experimental magnetons.

C. A. S.

1744. Two Varieties of Solutions of Cobaltous Salts: Relation of Magnetic State to Dilution. A. Lallemand. *Comptes Rendus*, 193. *pp.* 1323–1325, *Dec.* 21, 1931. The two varieties of solutions of cobaltous chloride described by Trümpler: (*a*) with constant, and (*b*) with variable magnetic susceptibility are obtained (*a*) by preventing the dissolving crystals (of $CoCl_2$, $6H_2O$) from being in presence of a concentrated solution, *e.g.* by continual agitation; (*b*) by preparing at first a very concentrated solution, subsequent dilution having no effect. The magnetic moment of the "variable" solution of whatever concentration is practically constant (25), but the Curie point rises from $-18°$ for a concentration of $0 \cdot 072M$, to $-7 \cdot 1°$ for $0 \cdot 0125M$, the molecular field being thus a function of the concentration. [See Abstract 1726 (1928).] C. A. S.

1745. Magnetic Properties of Iron above the Curie Point. L. Néel. *Comptes Rendus*, 193. *pp.* 1325–1326, *Dec.* 21, 1931.—By determining the ferromagnetic (θ_f) and paramagnetic (θ_p) Curie points, and the Curie constant (c) for a series of Fe-Sn (87·21–95·23 % Fe) and Fe-Si (89·72–97·04 % Fe) alloys, and extrapolating to nil Sn or Si, the values for β-iron (which unalloyed changes to γ-iron before the required temperature is reached) are deduced as θ_f 772°, θ_p 815°, and c 0·02256.
C. A. S.

1746. Magnetic Properties of Gold-Iron Alloys. J. W. Shih. *Phys. Rev.* 38. *pp.* 2051–2055, *Dec.* 1, 1931.—The alloys of gold and iron of different compositions ranging from 0·07 to 10 % iron by weight have been studied. It was found that the alloys containing 0·1 to 5 % iron are paramagnetic. Their susceptibilities decrease with rising temperature in a characteristic way, but do not follow either Curie's law or Weiss' law exactly. The square root of susceptibility increases linearly with the percentage of iron atoms added. Thus the gold-iron series does not show the same property as the nickel-copper alloys whose susceptibility increases with temperature in certain ranges. The behaviour of the iron atoms in the alloy and some correlations between magnetic susceptibility, density and melting point are discussed. AUTHOR.

1747. Cause of High Permeability in Air-Quenched Permalloy. K. Honda. *Tohoku Univ., Sci. Reports*, 20. *pp.* 731–735, *Dec.*, 1931. *Report No.* 282 *of the Research Inst. for Iron, Steel and other Metals.*—An explanation is suggested of the high permeability of air-quenched permalloy. If it is assumed that iron quenched from 700° C. preserves at ordinary temperatures the high permeability which it has at that temperature, then a rapid cooling from the neighbourhood of the critical temperature results in a highly permeable state at room-temperature. This is stated to be more easily accomplished where the metal forms a solid solution. On the author's theory of magnetism the atoms of a ferromagnetic substance have a spherical form at ordinary temperatures, but at higher temperatures the atoms are deformed, and rotational vibrations become sensible and increase in amplitude. If by rapid cooling the deformed shape of the atoms can be preserved down to room temperature, the thermal agitation even then exerts a considerable effect on the rotational vibration of the atoms, consequently facilitating magnetisation and increasing the permeability. Several other points are discussed in the light of the same theory. S. G. B.

1748. A.C. Magnetisation of Iron. H. S. Hallo and R. H. Borkent. *Arch. f. Elektrot.* 25. *pp.* 796–812, *Dec.* 18, 1931.—The magnetic induction in iron is no linear function of the magnetising ampere-turns. If a coil with iron core is subjected to a tension of sine-form the current flowing in the windings does not follow a course which can be expressed by a sine function. The problem is treated mathematically and the action of eddy currents is considered, the whole development being illustrated with numerous curves. J. J. S.

1749. Problem of Rotating Magnets. W. B. Pietenpol and E. C. Westerfield. *Phys. Rev.* 38. *pp.* 2280–2289, *Dec.* 15, 1931.—Ampere's problem of a cylindrical magnet free to rotate about its axis when a current enters at some point on the side of the magnet and leaves along the axis is treated by applying Ampere's original formula directly to the amperian currents which, according to the most commonly accepted

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theory, account for the magnetic properties of a body. For the torque on a symmetrically magnetised magnet, an expression in agreement with that of Zeleny and Page, and of Kimball, is obtained. However, this method of attack indicates that this torque is due only to the current in the portions of the circuit not attached to the magnet, contrary to the conclusion of Zeleny and Page. In the case of an asymmetrically magnetised magnet, it is found that the same expression holds provided only that the current is symmetrical in the portion of the circuit not mechanically attached to the magnet. This shows that the expression is more general than indicated by Zeleny and Page, in that they employed a symmetrical distribution of current within as well as without the magnet. AUTHORS.

1750. Mechanical Aspects of Electricity. L. B. Atkinson. *Inst. Mech. Eng., Proc.* 121. *pp.* 145–178, 1931. *Hawksley Lecture. Abstracts in Engineering,* 132. *p.* 615, *Nov.* 13, 1931. *Engineer,* 152. *pp.* 509–511, *Nov.* 13, 1931.—A summary of Faraday's and Maxwell's theories of electricity with a short statement of modern views. The chief sections of the discourse are as follows: (1) The modern view of electricity, (2) electrons at rest: the nature of the electric action and the mechanical energy involved, (3) electrons in motion: the electromagnetic field, (4) electro-mechanical actions of a single electric circuit, (5) electro-mechanical actions of two circuits, (6) practical application of the mechanical action of electric currents, (7) the law of electromagnetic induction, (8) magnitude of the electromechanical forces, (9) physical conception as to electromagnetism.
J. J. S.

1751. Steady Motion of Two Doublets. M. A. Higab. *Phil. Mag.* 12. *pp.* 993–1015, *Nov.,* 1931.—The steady motion of two electrified doublets moving under each other's action is classified and discussed. The conditions for steady motion are found in each case. H. H. Ho.

1752. Analogy between the Electromagnetic Field and a Fluid Containing a Large Number of Vortex Filaments. J. J. Thomson. *Phil. Mag.* 12. *pp.* 1057–1063, *Nov.,* 1931.—The field equations for a liquid full of vortex filaments are shown to be, in general, of the same type as Maxwell's equations of the electromagnetic field, and in special cases, as Schrödinger's equation. The lines of electric force being represented by the filaments, the motion of the filaments represents the magnetic force.
J. S. G. T.

APPARATUS AND INSTRUMENTS.

1753. Apparatus for the Determination of Hysteresis Curves. L. F. Bates. *Journ. Sci. Instruments,* 8. *pp.* 376–378, *Dec.,* 1931.—A method of measuring the intensity of magnetisation of a ferromagnetic rod is described. It is measured by the difference in two currents, passed through the coils of a small Helmholtz galvanometer, necessary in two cases to cause the magnet system to set perpendicularly to the magnetic meridian: first, when the needle is acted upon by the earth's field only; next, when it is acted upon by the earth's field together with the field due to the magnetised rod. AUTHOR.

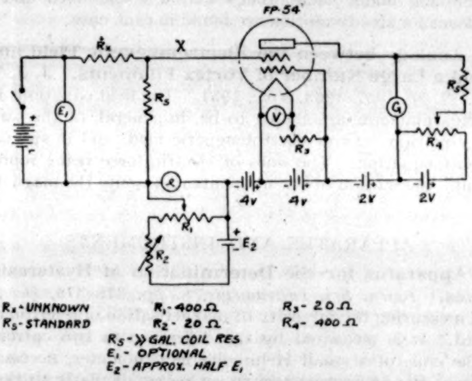
1754. Use of the Magnetometer. H. Pécheux. *R.G.E.* 30. *pp.* 1019–1024, *Dec.* 26, 1931.—A formula is deduced which permits the use of the magnetometer for the determination of the strength of magnetic poles. The discussion of the results, as also the theoretical treatment of the problem, establish the optimum conditions for such measurements. Results are given in tables constructed from theory and experiment and are in good agreement, even for feebly magnetised magnets of about 10 cm. in length. Experimental details and limits of error are well expressed.

S. G. B.

1755. Electrostatic Machines. H. Chaumat and E. Lefrand. *Comptes Rendus,* 193. *pp.* 1176–1178, *Dec.* 7, *and pp.* 1404–1405, *Dec.* 28, 1931.—The method employed makes use of the principle of the Faraday cylinder. When a charged body is introduced into, and touches the inside of the cylinder, the whole of its charge is given up. The authors use one or more conducting troughs or " portfolios " of **U** section, surrounding the periphery and sides of the glass or ebonite plate of the machine. In a simple form of their machine the glass or ebonite plate is electrified by friction, and then passes into the trough, to which it gives up its charge. The trough itself is surrounded by another conducting container, the two surfaces forming the electrodes of a condenser. A difference of potential of 87,000 volts was produced with an ebonite plate 18 cm. in diameter, and the sparks were heavier than those obtained with a Ramsden machine twice as large. A somewhat different form of the machine, with two troughs, and two chargers connected to the poles of a 100-volt battery, is capable of giving 500,000 volts at 1200 r.p.m. The diameter of the ebonite plate is 46 cm.

H. N. A.

1756. Method of Measuring Very High Values of Resistance. G. M. Rose, Jr. *Rev. Sci. Instruments,* 2. *pp.* 810–813, *Dec.,* 1931.—The method is essentially a modification of the standard one in which the current passed through the resistance by a known e.m.f. is measured by means of a sensitive galvanometer. In place of the galvanometer a " Pliotron " (4-electrode valve) is used, the unknown resistance being inserted at R_x (see fig.). The theory of the arrangement is given, as well as certain practical hints. The method is suitable for the measurement of resistances of the order 10^6–10^{17} ohms.



G. E. B.

1757. New Galvanometer Relay. S. Reisch. *Zeits. f. techn. Physik,* 12. 11. *pp.* 541–549, 1931.—A thin metal foil is disposed between two magnetic poles and two fixed parallel electrodes, in such a way as to give two low-capacity condensers, one between the foil and one fixed electrode, and the other between the foil and the second electrode. The two condensers are then connected to two triodes in a push-pull arrangement, the fixed plates to the respective grids, and the foil to the filaments. The grids of the triodes are supplied with l.f. current by means of an ancillary generator, and the anode circuit contains resistances and a galvanometer. When a current to be measured traverses the foil, the motion of the foil varies the capacity of the grid condensers, and hence deflects the galvanometer in the anode circuit. The theory of the circuit arrangement is discussed mathematically. G. E. B.

1758. New Type of Glass Discharge Tube for Kathode-Ray Oscillographs. F. Hauffe. *Zeits. f. techn. Physik,* 12. 11. *pp.* 560–562, 1931.—In a kathode-ray oscillograph of the cold-kathode type, the geometrical dimensions of the discharge tube are of importance, and in order to secure good definition and brightness of the kathode stream, a high exciting voltage is necessary. The various methods of effecting improvements are discussed, in particular one already described by Hochausler and Zumpe, in which a narrow discharge tube is surrounded by an envelope of much greater volume, the space between the two being highly evacuated. It is claimed that the narrow tube gives more satisfactory results when its outer surface is not exposed to air at normal pressures than when used in the normal way. G. E. B.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

1759. Paints for Reflecting Biologically-Important Ultra-Violet Radiation. M. Luckiesh and L. L. Holladay. *Frank. Inst., J.* 212. *pp.* 787–795, *Dec.,* 1931.—As the results of experiments of the reflecting powers of various paints in the ultra-violet, it appears that ordinary brands of glue, linseed oil and varnishes are not very well suited for binders and vehicles in making ultra-violet reflecting paints. On the other hand, with either casein or nitrocellulose lacquer very good paints should be made which reflect from 0·55 to 0·65 of the biologically-important ultra-violet radiation. A large proportion of magnesium oxide, magnesium carbonate, aluminium oxide or a combination of them appears necessary to produce a paint with the desired property. W. V. M.

1760. Calibration of the Lovibond Tintometer and of the Actinometer for the Levy-West Ultra-Violet Light Pastilles. P. Wright. *Brit. J. of Radiology,* 4. *pp.* 715–721, *Dec.,* 1931.—In 1926 Levy and West suggested a pastille method to estimate ultra-violet light dosage, within the range of 3800 to 2300 Å., with pastilles of chloralformamide and diphenylamine. The colour of the pastilles was compared with a set of standard pigments, or, for more accurate determinations, by means of a tintometer employing red and yellow filters. The standard pigments were obtained by exposing pastilles to a tungsten arc for measured intervals of time. This method is open to error owing to fluctuations in the emission of ultra-violet rays from the tungsten arc. In the present paper details are given of tests free from this objection, as the standard tints were measured by means of a photoelectric cell. The tests were of two types: (1) Comparison of the dummy tints of the Levy-West actinometer with those of the Lovibond tintometer. (2) Comparison of the dose estimated by the Levy-West actinometer and by the Lovibond tintometer with the dose, as measured by a photoelectric cell. Full particulars of the tests are given and the results summarised by a series of comparative curves showing the differences obtained. As a result of these tests new comparative standard tints have been evolved, which have been found to be accurate by means of the photoelectric cell method of test. B. J. L.

1761. Fields of Radiation from Radon Seeds. H. S. Souttar. *Brit. J. of Radiology*, 4. *pp.* 681–688; *Disc.*, 688–689, *Dec.*, 1931.—An attempt to discuss mathematically the fields of radiation around radioactive sources used in therapy. The case of a solid sphere of radioactive material is solved and it is shown that in order to obtain as uniform a field as possible the radioactive material should be concentrated near the surface of the sphere. A ring-shaped source is also discussed, and its importance indicated. W. V. M.

1762. Measurement in r-Units of γ-Rays from Radium. W. V. Mayneord. *Brit. J. of Radiology*, 4. *pp.* 693–708; *Disc.*, 708–710, *Dec.*, 1931.—The paper discusses the physical aspects of the problem of dosage in radium therapy. Various units are discussed and reasons given for the choice of the *r*-unit. Experimental arrangements are described, including a small ionisation chamber suitable for measurements in the vicinity of a radium needle containing a few mg. of Ra. The apparatus is calibrated in *r*-units by subjecting the chamber to a beam of hard X-rays, which is simultaneously measured by means of a second thimble chamber. The distribution of intensity around a 5-mg. needle is mapped out. The intensities in *r*/mg. hr. are measured and found to be in agreement with experiments by Glasser. Using probable data the intensity of radiation at definite distances from a radioactive source is calculated and shown to agree with the experimental result. The relationship between the international *r* and the Solomon R is calculated, and it is shown that 1*r*/sec. = 1·65 R. This value is in good agreement with experimental results. Other clinical units are discussed. W. V. M.

1763. H.F. Power Indicator. K. Heinrich. *E. u. M.* 49. *pp.* 831–833, *Nov.* 8, 1931.—At frequencies of the order of $10^6 - 10^8 \sim$, ordinary methods of power measurement are inapplicable, but biological reactions occur. To indicate the energy consumed, an arrangement has been used in which a glow-lamp connected to one pole of the oscillating circuit radiates to a selenium cell; the change of resistance of the latter due to light stimulus is measured in a normal way and is taken to indicate the strength of the " dose " in the first circuit. Test results are given for discharges through various liquids, the temperature-rise of the latter being measured by thermometer. G. F. F.

1764. X-Ray Diffraction Studies of Calculi. S. Ranganathan. *Indian Journ. Phys.* 6. *pp.* 433–444, *Nov.* 30, 1931.—The author's object has been to obtain information as to the method of deposition of pathological calculi in human beings and animals by analysing the crystal structure of these calculi by the X-ray method. Cholesterol stones and the molecular structure of cholesterol are particularly described. It is determined that these calculi are formed by the deposition of the material in the crystalline state, although there is variation in the order of magnitude of the crystals. Vesical calculi and pure uric acid, used for comparison, gave identical spacing of the diffraction rings. Gallstones show the characteristics of cholesterol, but the rings of the pathological specimens were contracted. An explanation is offered of this fact, upon the basis of the orientation of the crystals in certain preferential directions and the fine state of division of the crystals. An explanation upon the basis of this X-ray analysis is given for the existence of two types of gallstones, *i.e.*, the pigmented and non-pigmented varieties. The Debye and Scherrer method of X-ray analysis was employed, with a Shearer copper target X-ray tube, the crystal spacing being calculated by the Bragg formula.

B. J. L.

1765. 200,000-Volt X-Ray Tube. W. W. Hansen. *Rev. Sci. Instruments*, 2. *pp.* 820–823, *Dec.*, 1931.—The tube, which is designed for operation on a h.t. supply having an earthed mid-point, consists essentially of a central discharge chamber, and two insulating arms carrying the anode and kathode respectively. The filament assembly is mainly of steel, the filament itself being shielded. The tube is continuously evacuated by means of a diffusion pump operating with *n*-dibutyl phthalate which is connected *via* a vapour trap to the discharge chamber. G. E. B.

1766. Duplex Therapy and other Electro-Medical Applications. G. G. Blake. *Roy. Soc. Arts, J.* 80. *pp.* 128–148; *Disc.*, 148–153, *Dec.* 18, 1931. W. V. M.

1767. Electricity in Healing. Recent Advances in Surgical and Medical Applications. E. P. Cumberbatch. *El. Rev.* 109. *pp.* 799–801, *Nov.* 27, 1931.—A description is given of the medical and surgical use of h.f. current (diathermy). The advantages of the diathermic scalpel over the ordinary surgical scalpel, in respect to the automatic sealing of the severed blood vessels by the electrical instrument and the avoidance of the dissemination of cancer cells, as may occur with the ordinary scalpel when cancerous tissue is being dealt with, are described. It is stated that it is not yet decided whether the best results are obtained with damped or undamped oscillations. The difference between " diathermic coagulation " and " electro-desiccation " is considered. Diathermic coagulation is claimed to have been first utilised in this country at St. Bartholomew's Hospital in 1910. With this method difficulty arises in judging the exact extent to which the tissues will ultimately show the effects of such coagulation. In the electro-desiccation method the tissue is killed by the direct effect of small h.f. sparks. Electrothermic surgery is then considered, and it is pointed out that the effect of the frequency of the oscillation, for particular requirements, is still unknown and unsettled. Medical diathermy is then described in relation to diseases of the eye, ear, lungs and pelvic organs, the effect of heat being carried away by the abundant blood supply in certain parts of the body being considered. Treatment of arthritis and the artificial induction of fever for therapeutic purposes are described. It is suggested that the beneficial results of vaccines in some diseases are merely due to these injected foreign media giving rise to increase of the body temperature, and the recent method of treating general paralysis, by inducing malaria fever, is again stated to be merely due to the increase of temperature, suggesting that such increase of temperature, with equally good therapeutic results, can be obtained by the use of diathermic treatment, without the risks which are involved by inducing malaria. Future possible applications of diathermy are foreshadowed. B. J. L.

CHEMICAL PHYSICS AND ELECTROCHEMISTRY.

1768. Adsorption at Surface of a Solution. W. F. K. Wynne-Jones. *Phil. Mag.* 12. *pp.* 907–912, *Nov.*, 1931.—The values deduced from the equation $\Gamma = -c/\mathrm{RT} \times d\sigma/dc$ for the adsorption, Γ, of ethyl alcohol at the surface of its aqueous solution [see Schofield and Rideal, Abstract 2412 (1925)] are not those of the total amount present at the surface, but of the surface excess over the amount normally present in absence of adsorption. A method is devised for calculating the total amount which gives results in accordance with the conception of a unimolecular layer of alcohol at the surface of solutions containing more than 30 % alcohol. Similar results are obtained for solutions of methyl alcohol and acetone. C. A. S.

1769. Adsorption of Iodine on Vacuum-Sublimed Barium Chloride Films and its Dependence on Temperature. J. H. de Boer. *Zeits. f. phys. Chem.* 14. *Abt.B.* 6. *pp.* 457–470, *Nov.*, 1931.—Vacuum sublimed $\mathrm{BaCl_2}$ films show in general the same behaviour in their adsorption of iodine as those of $\mathrm{CaF_2}$ and $\mathrm{BaF_2}$. At lower temperatures for the same amount of surface and relative pressure less iodine is adsorbed than at room-temperatures. The isotherms obtained can be expressed by the formula $\log\left(-\log\frac{p}{\mathrm{K}_3p_0}\right) = \beta m + \gamma$, where $\mathrm{K}_3 = 1\cdot45$ and $\gamma = 0\cdot63$. β is dependent on the surface area. J. K.

1770. Gas Content and Adsorption of Electrolytes by Active Charcoal. Part VII. B. Bruns and W. Pyschow. *Zeits. f. phys. Chem.* 157. *Abt.A.* 1–2. *pp.* 57–64, *Nov.*, 1931.—The influence of ozone is described under various conditions, and furthermore deductions are made from the adsorption properties of the charcoal as to the condition of its surface. It is shown that during the development of ozone on charcoal placed in water or in an electrolyte solution that the charcoal takes on a higher positive potential than when in an oxygen atmosphere. This in addition leads to an increase in the amount of acid adsorbed. By the formation of ozone on dry charcoal, acid oxides are formed on its surface, and this gives the charcoal the property to adsorb alkalies, while the acid adsorption drops to zero. [See also Abstract 3986 (1931).] J. K.

1771. Sorption Process in the Zeolite Chabazite. M. G. Evans. *Roy. Soc., Proc.* 134. *pp.* 97–102, *Nov.* 3, 1931.—The changes in the zeolite chabazite during sorption is investigated by means of X-ray examination of single crystals and of powders. The heats of sorption for very small additions of ammonia to the zeolite are given. A theory is proposed to explain the results obtained. J. K.

1772. Kinetics of Adsorption Processes. A. R. Ubbelohde and A. Egerton. *Roy. Soc., Proc.* 134. *pp.* 512–523, *Dec.* 2, 1931.—A method is described for studying the adsorption isothermal in great detail, using different rates of removal of the sorbate. Data are quoted for the adsorption of hydrogen on charcoal at the temperature of liquid oxygen. The rate of establishment of equilibrium on desorption is very rapid. The possible influence of the rotational state of the adsorbed molecules on the adsorption potential, and on the discontinuities in the isotherm, is also discussed. The difference in viscosity of a 75 % mixture of ortho- and para-hydrogen and of a 50 % mixture is shown to be less than 0·3 %. H. H. Ho.

1773. Heat of Adsorption of Hydrogen on Platinum. E. B. Maxted and N. Hassid. *Chem. Soc., J. pp.* 3313–3324, *Dec.*, 1931.—The differential heat of adsorption of hydrogen on platinum is independent of the amount of hydrogen adsorbed over the range studied. The maxima obtained from earlier observations [see Abstract 1697 (1931)] are to be attributed to experimental error. F. J. W.

1774. Apparent Volumes of Salts in Solution. Part II. A. F. Scott. *J. Phys. Chem.* 35. *pp.* 3379–3396, *Nov.*, 1931.—The results are given of an attempt to interpret the apparent molal volumes of salts in solutions from the point of view that at the critical limit of the solution state, the apparent molal volume of a salt is an approximate measure of the volume of the salt as solute. Use is made of Masson's equation. [For Part I see Abstract 4326 (1931).] J. K.

1775. Heat of Solution of Sodium Carbonate and Specific Heats of its Solutions. J. C. Swallow and S. Alty. *Chem. Soc., J. pp.* 3062–3079, *Nov.*, 1931.—Determinations of the heats of solution of sodium carbonate and the specific heats of the solutions were made in a specially designed adiabatic calorimeter, which was capable of great accuracy. The determinations were made over a range of concentrations from 10 % to 28·40 %, and the heats of dilution were obtained in the course of the determinations. The results led to the expression for the specific heat at 30° C. : $S_{30} = 0{\cdot}9986 - 0{\cdot}01123X + 0{\cdot}000223/X^2$, where X is the concentration of the solution in gm. per 100 gm. The heat of dilution is given by the equation: $Q = -2{\cdot}066Y/(Y + 54{\cdot}8)$, where Y is the number of mols. of water added in diluting the 28·24 % solution per mol. of sodium carbonate. The calculated values agreed very closely with the experimental results. F. J. B.

1776. Surface Films of Insoluble Substances on Aqueous Solutions. N. K. Adam. *Kolloid Zeits.* 57. *pp.* 125–139, *Nov.*, 1931.—A *résumé* of published work, describing the methods used in investigating these surface films and the results obtained. T. H. P.

1777. Colloidal Properties of Polonium. I. E. Starik. *Zeits. f. phys. Chem.* 157. *Abt.A.* 3–4. *pp.* 269–284, *Nov.*, 1931.—The behaviour of polonium on dialysis is investigated, and it is conclusively shown that the prior treatment of the dialyser with different salts and dyestuffs has no effect on the capacity of polonium for dialysis. Glass and parchment adsorb polonium two to three times more in acid than in alkaline media. Polonium is readily adsorbed in alkaline, neutral and acid media by colloids of opposite charge. Soot adsorbs both in alkaline and acid media, but in acid media the adsorption appears to be the stronger. It is shown that all the described facts on the behaviour of polonium in solution can be best explained on the assumption of its colloidal condition. J. K.

1778. Colloidal Sulphur. H. Bassett and R. G. Durrant. *Chem. Soc., J. pp.* 2919–2956, *Nov.*, 1931.—It is shown that Oden's colloidal sulphur is probably the soluble salt of a sulphur-polythionate complex.

The polythionate is probably hexathionate. It is suggested that there is nothing between hexathionate and "colloidal sulphur." All the polythionate is stated to be in a "bound" condition in a freshly prepared sulphur sol and attached to the micelle, but as the sulphur sol ages more and more of the polythionate becomes free. The experimental results obtained on the coagulation of sulphur sols by salts are given in detail.
J. K.

1779. Solution of Gelatin in Liquids. E. W. I. Mardles. *Kolloid Zeits.* 57. *pp.* 183–194, *Nov.*, 1931.—Results are given for the determination of the solubility of gelatin in water at various temperatures. These show that the solubility relationships of proteins in many respects resemble those for crystalloids. They show a solubility limit which varies with the temperature. A striking rise in the solubility of gelatin takes place at above 26°. Gelatin shows a well-defined hysteresis in its solubility relationships as the solubility figures on drop of temperature are substantially higher than on rise in temperature. Gelatin, blood-albumen and other proteins are shown to be of a heterogeneous character. After washing the proteins are found to be less soluble. The lyophilic character of proteins is examined by the addition of numerous organic compounds. J. K.

1780. Colloidal Theory of the van der Waals Gas. S. Ray. *Kolloid Zeits.* 57. *pp.* 259–266, *Dec.*, 1931.—In a previous paper on the variability of the Avogadro number [see Abstract 199 (1928)] the author showed that N cannot be independent of size, and he now establishes that it cannot be independent of state. A colloidal theory for the gas particles is discussed. H. H. Ho.

1781. Thixotropy of Litharge and Glycerin. E. Karrer and P. Wasserman. *Physics*, 1. *pp.* 393–406, *Dec.*, 1931.—Thixotropy may be defined as change in viscosity, or as change in the hardness of the solid state, after mechanical agitation. Rate of hardening decreases with increase of glycerin (critical point near 32 %) and increases with rise of temperature. Water accelerates rate of hardening. Acids increase, bases decrease rate of hardening in general. Samples of litharge and of glycerin vary greatly because of differences in particle size, in composition and particularly amount of moisture. AUTHORS.

1782. Stratified Precipitations in Spirals. Suzanne Veil. *Comptes Rendus*, 193. *pp.* 1337–1339, *Dec.* 21, 1931.—Reference is made to the work of Liesegang and Schikorr. A photograph is given of a spiral obtained in gelatin by the interaction of ammonium bichromate and silver nitrate. [See also Abstract 1027 (1931).] J. K.

1783. Theory of the Electrification of Aerosols. H. S. Patterson. *Phil. Mag.* 12. *pp.* 1175–1182, *Dec.*, 1931.—The conditions governing the electrical behaviour of aerosols are considered, and equations giving the fraction of charged particles remaining after a specified interval are deduced for (1) slightly charged aerosols, such as are produced by volatilisation of material at relatively low temperatures, or, *e.g.*, in the formation of ammonium chloride from hydrogen chloride and ammonia at room temperature, and (2) highly charged aerosols, produced by violent chemical reactions and arc discharges. The equation for the first type is in satisfactory agreement with published data relating to ammonium chloride and with results obtained for blown smokes of stearic acid. The equation for the second type shows that in highly charged aerosols the fraction of charged particles remains approximately constant; this also agrees with published data relating to the aerosols of MgO produced by burning Mg ribbon in air. **Errata,** *ibid.*, 13. p. 736, March, 1932. H. F. G.

1784. Methods of High Temperature Treatment. P. P. Cioffi. *Frank. Inst., J.* 212. *pp.* 601–612, *Nov.*, 1931.—A method is developed for heating wire or tape samples of metals in gases at pressures of one atmosphere or less and at pressures greater than one atmosphere. A molybdenum-wound resistance furnace is designed, with a water jacketed steel container, in which irregularly shaped specimens can be heat treated in atmospheres of different gases at various pressures. F. J. B.

1785. X-Ray Investigation of Copper-Aluminium Alloys. G. D. Preston. *Phil. Mag.* 12. *pp.* 980–993, *Nov.*, 1931.—This investigation deals with that part of the Cu-Al system containing from 31 to 50 atomic % of aluminium. The lower limit coincides with the boundary of the well-known γ phase, the structure of which has been worked out by Bradley. According to the original X-ray investigation carried out by Jette, Phragmen, and Westgren, this phase field extends from the above limit up to 44 % Al, and is then followed in the constitutional diagram by the compound $CuAl_2$. Stockdale, however, by thermal and micrographical investigation of these alloys, interpolated another phase η, extending from 43–50 % Al, the limits of existence of the γ phase (δ in Stockdale's notation) being placed at 31–41 % Al. The present paper describes two new phases, hexagonal and orthorhombic (CuAl), which have been examined by the Laue and oscillating-crystal methods. Evidence is also submitted in favour of Rosenhain's views concerning the nature of intermetallic compounds. H. H. Ho.

1786. Thermodynamics of Thallium and Cadmium Amalgams. C. E. Teeter, Jr. *Am. Chem. Soc., J.* 53. *pp.* 3917–3940, *Nov.*, 1931.—The free energies of formation of thallium amalgams at 20° C. are calculated from the e.m.f. of thallium amalgams. The free energy-composition curve is found to be in accord with theoretical expectations. The heats of formation of liquid and partly solid thallium amalgams are calculated for temperatures of 20° and 30° C. The heats of solution of solid cadmium amalgam are measured at 25° C. and from these measurements the heats of formation are calculated. Certain of the results are in disagreement with the heats of formation calculated from the data of Smith on the temperature coefficient of e.m.f. of cells containing cadmium. Possible reasons are given for the disagreement. On the whole, the conclusions of Bijl, Smith, Cohen and Mehl concerning the system cadmium-mercury, are substantiated. F. J. B.

1787. Decomposition of Nitrous Oxide by Kathode Rays. G. R. Gedye. *Chem. Soc., J. pp.* 3016–3022, *Nov.*, 1931.—A beam of electrons from a Lenard discharge tube, of the type described by Gedye and Alibone [see Abstract **2102** (1931)], was passed through a thin aluminium window into a reaction vessel containing N_2O. The reaction taking place during the bombardment may be represented by the equation $4N_2O = 3N_2 + 2NO + O_2$. This is followed by the reaction $2NO + O_2 = 2NO_2$, the rate of which falls off very rapidly with pressure. It becomes possible to arrange matters so that this reaction becomes complete. Each molecule decomposed requires 8·1 electron-volts, and on the assumption of 31·6 electron-volts per ion pair this gives for the M/N ratio, the number of molecules reacting per ion pair, the value 3·9. The photochemical and the ionic reactions are strictly similar, about four molecules reacting per excited or ionised molecule formed. It is supposed that the first step, after absorption of the quantum or recombination of ions, is dissociation of the molecule into $N_2 + O$, and the possible subsequent steps in the reaction are discussed. H. N. A.

1788. Gaseous Products from the Action of Kathode Rays on Hydrocarbons. C. S. Schoepfle and C. H. Fellows. *Indust. and Engin. Chem.* 23. *pp.* 1396–1398, *Dec.*, 1931.—A number of hydrocarbons have been subjected to kathode-ray bombardment and the volume and composition of the gaseous products determined. Saturated hydrocarbons give large amounts and unsaturated hydrocarbons small amounts of gas consisting of hydrogen and saturated hydrocarbons; aromatic hydrocarbons give practically no gaseous products; branched-chain compounds give more methane and other gaseous saturated hydrocarbons than straight-chain compounds. The reaction is shown to be similar to that of hydrocarbons under the influence of the corona discharge or of α-particles. AUTHORS.

1789. Reactions in the Brush Discharge. A. P. Davis. *J. Phys. Chem.* 35. *pp.* 3330–3352, *Nov.*, 1931.—When acetone decomposes under the influence of the brush discharge the whole molecule breaks up; condensation with evolution of gas occurs to only a small extent. The principal reaction results in the formation of ethane and carbon monoxide, and the hydrogen, ethylene and acetylene formed among the products are derived from decomposition of the ethane. The primary decomposition cannot be brought about by heat alone, but it resembles the reaction which is produced by ultra-violet radiation, and is therefore probably effected by the light emitted by the discharge. Ketene is produced directly from the acetone to the extent of about 5 %. The conflicting results reported by previous workers are critically reviewed. The brush discharge effects decomposition of benzene, a chloroform-soluble resin being the main product. Diphenyl and *p*-diphenylbenzene are also formed, the former at least as a result, probably, of the ultra-violet radiation from the discharge. The hydrogen which must be liberated is apparently used up in a secondary reaction. H. F. G.

1790. Distribution of Chemical and Thermal Effects in the Spark Gap. H. Takô. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 337. *pp.* 57–67, *Nov.*, 1931.—The earlier photographic and spectroscopic studies of the three-part spark [see Abstract 3526 (1930)] have been extended to an investigation of the chemical and thermal changes at different parts of the discharge. The chemical and thermal actions are due mainly to the middle section. F. J. W.

1791. Effect of Frequency on the Condensed Discharge Ignition of Carbonic Oxide-Air Detonating Gas. G. I. Finch and H. H. Thompson. *Roy. Soc., Proc.* 134. *pp.* 343–351, *Nov.* 3, 1931.—The electrical ignition of gases has been studied by Wheeler [see Abstract 1145 (1925)], Jones [see Abstract 1244 (1929)], Holm [see Abstract 2008 (1931)], and Morgan [see Abstract 2099 (1931)], all of whom have put forward facts purporting to establish a purely thermal theory which, it is claimed, explains the mechanism of ignition as a whole, whether by electric discharges or otherwise. Various well-established facts apparently contradictory to such theory are now cited, and it is pointed out that the electrical theory of ignition implies that the ignition of an explosive gaseous mixture is determined by the setting-up of a sufficient concentration of suitably activated molecules of the constituent gases. Experiments, now described, on the ignition of equivalent mixtures of carbonic oxide and air by means of condenser discharges give results which render untenable the thermal theory of ignition, as they show that discharge oscillation frequency is a far more potent factor in determining ignition than either the rate or the amount of energy-dissipation in the discharge.

T. H. P.

1792. Gas-Solid Equilibria. Part III. Pressure-Concentration Equilibria between Silica Gel and (a) Water, (b) Ethyl Alcohol. B. Lambert and A. G. Foster. *Roy. Soc., Proc.* 134. *pp.* 246–264, *Nov.* 3, 1931.—It is shown that the water–silica gel system is definitely peculiar in behaviour and markedly different from the benzene–silica gel and the alcohol–silica gel systems. The water isothermals show hysteresis phenomena and rise very much more steeply from the concentration axis than the benzene and alcohol isothermals; they cannot be followed experimentally up to the saturation pressures of pure water at the temperatures investigated. The pressure-concentration isothermals for the alcohol–silica gel system are shown to resemble those for the benzene–silica gel system described in Part II [see Abstract 2023 (1929)], being reversible, showing no hysteresis phenomena, and giving saturation pressures equal to those of pure ethyl alcohol; but the alcohol isothermals differ in shape from those of benzene, whilst the alcohol–silica gel system displays irregularities in behaviour not shown by the benzene–silica gel system. A partial explanation is submitted based on the assumption that the volume of the gel changes with its water-content, *i.e.*, it is not strictly non-elastic.

H. H. Ho.

1793. Attack of Platinum and Tungsten by Iodine. G. van Praagh and E. K. Rideal. *Roy. Soc., Proc.* 134. *pp.* 385–404, *Dec.* 2, 1931.—The earlier experiments [see Abstract 2628 (1929)] are extended to the reactions of Pt and W with I vapour at low pressures. The different oxidisability of the two metals may be accounted for by the large difference between the work functions of the metals, which may also explain the fact, shown by the thermionic data, that the adsorption of I on Pt is stronger than on W. Towards I the metals show the expected behaviour, W but not Pt being attacked at low temperatures by molecular iodine. At high temperatures, dissociation of iodine into atoms occurs more readily on Pt than on W, owing to stronger adsorption of the gas on the former metal; attack of W by atomic I is more ready than that of Pt. A distinction between the various possible modes of these heterogeneous actions may be made by comparing the observed rates of reaction with those calculated from the various assumptions involved. The attack of Pt by I is thus a two-stage process, no surface attack occurring at relatively low temperatures. At about 1300° K. the iodine dissociates, and at about 1400° K. the atomic I attacks the metal forming the volatile iodides PtI and PtI_2. The absolute rates of these reactions are considered and the heat of adsorption of the atomic I on Pt is calculated to be 53,700 cal. per gm.-mol. W is attacked by I, forming a non-volatile iodide, at low temperatures, the rate of reaction being controlled by the diffusion of iodine through the iodide film. The compound is formed below 1445° K., but not above 1505° K., and appears to be a compound with a definite dissociation pressure and not an adsorption complex. The film seems to be about 10 molecules in thickness. T. H. P.

1794. Photographic Investigation of Flame Movements in Gaseous Explosions. Parts IV, V and VI. W. A. Bone and R. P. Fraser. *Roy. Soc., Phil. Trans.* 230. *pp.* 363–385, *Dec.* 16, 1931.—Further experiments show how potent shock waves [see Abstract 3430 (1929)] are in abruptly accelerating the initial flame movements and ultimately setting up detonation in gaseous explosions. They prove, too, that detonation may be set up in a sufficiently explosive gaseous medium at the instant of its ignition, provided that the ignition is of sufficient intensity and the flame is simultaneously struck by a sufficiently powerful, extraneous shock wave, and that, in cases where such a medium is ignited by a detonator, the distance of flame run before detonation is set up seems to depend chiefly on the ratio of the velocity of the initial flame speed to that of the invisible shock wave emitted by the detonator used. Further evidence is obtained that, whenever detonation is established in a gaseous explosive medium, its initial speed exceeds, at least for something like 0·25 millisec., the normal speed which is afterwards established after a run usually of 0·5 m. or thereabouts. This normal speed, while constant for a particular explosive medium under given experimental conditions, may and often does vary somewhat with the internal diameter of the tube, as well as with temperature and pressure. Investigation of the phenomenon described by Campbell and Finch [see Abstract 221 (1929)] gives results consistent with a suggestion made by H. Levy to the effect that the observed " spin " in detonation is due, not to rotation of the medium as a whole, but to the " head " of detonation travelling spiral-wise as a wave-front through the medium in the tube at the observed flame speed, the banded appearances of the " tail " being ascribable to periodic waves along itself. The flame photographs shown are described separately. T. H. P.

1795. Kinetics of Gas Electrodes. K. Bennewitz and W. Schieferdecker. *Zeits. f. phys. Chem.* 157. *Abt.A.* 1–2. *pp.* 32–56, *Nov.*, 1931.—The theory of Langmuir is applied to gas electrodes in order to explain certain passivity phenomena. The existence of two adsorption compounds on the surface of the electrodes led to the investigation of the law of mass action for the electrode surfaces under stationary and non-stationary conditions of a platinum electrode charged with hydrogen or oxygen. This included the examination of residual current, covering and reaction passivity. The conclusions from the theory are in qualitative agreement with experimental results. F. J. B.

1796. Determination of Glass Electrode Potentials by Means of a Null Ballistic Valve Electrometer. C. Morton. *Chem. Soc., J.* *pp.* 2977–2983, *Nov.*, 1931.—The instrument is described in detail. It is characterised by complete stability of the zero and by high sensitivity, which may be increased at will by standard methods of l.f. amplification. An e.m.f. of 0·01 mV applied to a resistance of 1000 megohms may be detected. H. F. G.

1797. Determination of Glass Electrode Potentials by Means of a Valve Potentiometer. C. Morton. *Chem. Soc., J. pp.* 2983–2991, *Nov.*, 1931.—The valve potentiometer described is especially suitable for the measurement of glass electrode potentials. Its sensitivity increases with increase of resistance of the electrode, and is in direct proportion to the mutual conductance of the valve employed, so that a power or pentode valve should be used. A sensitivity of 38 μA per mV has been attained. The application of the valve potentiometer to differential potentiometric titration with glass electrodes is discussed, emphasis being laid on the high degree of accuracy attainable and the simple form of titration cell which may be used. H. F. G.

1798. Electrolytic Dissociation and the Raman Effect. L. A. Woodward. *Phys. Zeits.* 32. *pp.* 777–793, *Oct.* 15, 1931.—A spectrograph was constructed of especially large light-gathering power ($f\,1{\cdot}5$) using two kinematograph projectors and three large prisms. The large angle of the collimator necessitated bulky scattering vessels of a conical shape. The apparatus was used to investigate electrolytic dissociation. Ordinary salts give in solution solely the effect of the ions, and thus appear to be largely dissociated. In certain cases (*e.g.*, $HgCl_2$ and $Hg(CN)_2$) where on other grounds little dissociation is expected, the Raman effect shows the existence of undissociated molecules. In sulphuric and nitric acids, changes take place with change in concentration, which suggest alteration in the degree of dissociation. A partial dissociation of the HSO_4' ion in $KHSO_4$ was observed. The other solutions investigated were those of HCl, HF, HIO_3, CCl_3COOH, $CHCl_2COOH$, NaOH, KOH, and in these no connections between the Raman spectra and dissociation could be observed. A. C. M.

1799. Viscosity of Dilute Solutions of Strong Electrolytes. W. E. Joy and J. H. Wolfenden. *Roy. Soc., Proc.* 134. *pp.* 413–427, *Dec.* 2, 1931.—Results are given of measurements of the viscosity of potassium chloride and chlorate, rubidium nitrate and nitric acid solutions over the concentration range N–$0{\cdot}002\ N$ at 18° and 35°. The viscosities of all these solutions at high dilution were greater than that of pure water, in accordance with the prediction of Jones and Dole [see Abstract 1272 (1930)]. The limiting slopes of the viscosity-concentration curves and their temperature coefficients agree, within the experimental error, with the values predicted by the Falkenhagen-Dole equation. The confirmation of the ionic-atmosphere theory of strong electrolytes is thus extended to a further property of electrolyte solutions. T. H. P.

1800. Kohlrausch Conductivity Apparatus with Use of Thermionic Valve. E. Götte and W. Schramek. *Zeits. f. Elektrochem.* 37. *pp.* 820–823, *Nov.*, 1931.—The determination of the conductivities of solutions by the method of Kohlrausch was modified. A l.f. transmitter was employed to take the place of the usual battery, and a three-stage amplifier was placed in the arm of the bridge usually occupied by the telephone. A loud-speaker was used as the detector, instead of a telephone. When well screened and when the correct grid voltage was employed, the sound minimum in the loud-speaker was independent of the resistance.

F. J. B.

1801. Dispersion of the Conductivity of Aqueous and Non-Aqueous Electrolyte Solutions. H. Gaertner. *Phys. Zeits.* 32. *pp.* 919–

926, *Nov.* 15, 1931.—Measurements of the conductivity dispersion in aqueous solutions with $CaCrO_4$, $MgCrO_4$, $Ca_2Fe(CN)_6$ and $N(CH_3)_4 \cdot OC_6H_2(NO_2)_3$ [tetramethylammonium picrate] give results in good agreement with the theoretical conclusions of Debye and Falkenhagen. In methyl alcohol solution an effect of 5·5 % was observed with $MgSO_4$ with respect to KCl. In glycerol (*d* 1·26) to which 4 % of water was added, effects up to 500 % were noted, indicating a sixfold increase of the conductivity in the h.f. circuit towards KCl. It seems probable that, in spite of their magnitude, these effects are purely ionic effects as denoted by Debye and Falkenhagen, and that anomalous absorption of the glycerol plays only a subordinate part. The magnitude of the effects shows the importance of electric ionic forces in electrolytic solvents [see Abstract 2817 (1928)]. T. H. P.

1802. Electrolytic Solution Pressure. H. Hammerschmid and E. Lange. *Phys. Zeits.* 32. *pp.* 958–964, *Dec.* 1, 1931.—The general theory of electrolytic solution pressure is reviewed, and utilises the analogy of a two-phase system in considering the system electroneutral solid precipitate and saturated solution, for defining the ideal zero concentration and the ideal solution pressure. It is shown that the real solution pressure requires that the galvanipotential between two dissimilar metals should be taken into account and that the neglect of this factor caused errors in the recorded solution pressures. F. J. B.

1803. Excess Phenomena in the Electrodeposition of Metals. T. Erdey-Grúz and M. Volmer. *Zeits. f. phys. Chem.* 157. *Abt. A.* 3–4. *pp.* 182–187, *Nov.*, 1931.—It is found that when metals are deposited by electrolysis on an electrode of a different metal, irregularities occur in the current-voltage curves. This is shown to occur for the deposition of silver from solutions of silver acetate, and bismuth from bismuth chloride on to platinum electrodes, also for the deposition of the same metals from the same solutions on tantalum electrodes. The phenomenon is considered to be due to supersaturation. F. J. B.

1804. Measurement of Cataphoretic Velocity in a Concentrated Suspension. S. Komagata and R. Iwasaka. *Electrot. Laborat. Tokyo, Japan, Researches, No.* 325. [29 *pp.*], *Oct.*, 1931.—The method described, termed the " weight " method, depends on the fact that, when a suspension is placed under the influence of an electric field, cataphoresis occurs and causes the particles in the suspension to gather on the surface of the electrode. It is applicable only when the sample is so concentrated that the weight-increase of the deposition is measurable. If u_0 is the cataphoretic velocity (cm./sec./volt/cm.), d_0 the specific gravity of the suspension, p_0 the percentage weight of disperse phase in suspension, A the effective area of the electrode (cm.^{2}), W the weight of deposit in the suspension (grams), W*a* the weight of deposit in air (grams), p_0' the limiting value of weight percentage of disperse phase in deposit at $t = 0$, G the potential gradient (volt/cm.), and *t* the time,

$$u_0 = \frac{p_0'}{d_0 A G p_0}\left(\frac{d(Wa - W)}{dt}\right)_{t=0}$$

The factors required are readily determined with the apparatus described. Measurements made with suspensions of ball clay (12·67 %) and china clay (16·23 %) give results in satisfactory agreement with those found by the ordinary U-tube method. T. H. P.